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rear step bumper., packaged at a suggested price well below the suggested price of the items if purchased separately.

VALUE THAT TOYOTA CAN'T MATCH.

The box at the right compares Ranger XLT





Buckle up—together we can save lives.

Regular Cab with the equivalent Toyota Deluxe. Look how much Ranger gives you—from power steering to big outlined-white letter (OWL) tires. And its sticker price still beats Toyota's!‡

What's more, Ranger is backed by a 6/60 warranty that Toyota doesn't match. Small wonder it's No. 1!

6/60 WARRANTY.

Covers powertrains for 6 years/60,000 miles and body-panel rust-through for 6 years/100,000 miles. Restrictions and deductible apply.*

COMPARISON

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- Sliding Rear Window
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- Carpeting
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- Chrome Front Bumper
- Deluxe Wheel Trim

RANGER ADDS ALL THIS—AND STILL COSTS YOU LESS!

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- Light Group

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*Based on latest available model year manufacturers' reported retail deliveries.

**Ask your Ford Dealer for copies of these limited warranties.

†Ranger Package content may vary by state.

‡Based on manufacturers' suggested retail prices of Ranger XLT (with Special Value Package *86-1A) compared with Toyota Deluxe. Title, tax and destination charges extra.

BEST-BUILT AMERICAN TRUCKS 7 YEARS RUNNING.

Based on an average of owner-reported problems in a series of surveys of '81-'87 models designed and built in North America. At Ford, "Quality is Job 1."



FORD RANGER

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If you'd like to know more about taking the Army Reserve's GI Bill to college **BE ALL YOU CAN BE.** with you, call toll-free **ARMY RESERVE** 1-800-USA-ARMY.





72 COVER STORY

For years, America has lagged behind in constructing better performing and safer equipment for its Olympics. But all that is changing. —PM illustration by Jeff Manglat



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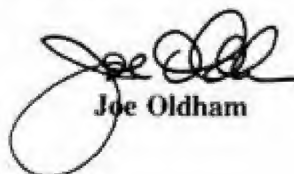


Toyota 4Runner: Beauty on the beach.

EDITOR'S NOTES

Popular Mechanics

WITH all eyes shifting to Calgary for the Winter Olympic Games, it's only natural to ask the inevitable question: What are our chances to win some of the gold? This year, thanks to the efforts of the Sports Equipment and Technology Committee of the U.S. Olympic organization, the answer is, pretty good. It had become quite clear after the '84 Winter Olympics that our efforts were pretty lax in sports where advanced-technology equipment played a major role in who won the gold medal. The SETC was formed and we are no longer lax. In fact, some of our equipment will be considered leading edge in the Olympic village. Our cover story in this issue on page 72 tells you why. . . . A few months ago in this column, I came down pretty hard on GM's Cadillac Motor Division. I griped about their cars and their management. As a Cadillac owner and an industry observer for 22 years, I figured I had the right. Apparently, some of you readers disagreed with my feelings regarding recent Cadillac products. You even said I was unfair, that I should take another look. Okay, I did. I recently drove an '88 Allante and an '88 Seville. I must say, Cadillac has gotten its act together. The Allante was one of the best cars I've driven in a long time, with strong performance, terrific handling and great styling. I thoroughly enjoyed my time with the car. In fact, the Allante has only one flaw: the convertible top mechanism. It took me a good 40 minutes to lower the top following the directions in the owner's manual. I own an '87 Corvette convertible and I can lower the top in a minute or less. The Allante's ragtop is ridiculous and mars an otherwise extremely nice car. I enjoyed the Seville, too. The car was black on black and was equipped with the touring suspension, wide Eagle GT tires and alloy wheels. In addition, it had the new, larger 4.5-liter V8 engine. This car hauled, and could easily blast around BMWs and other expensive foreign machinery. Congratulations, Cadillac. You showed me something. . . . Isaac Asimov, one of the most prolific writers of all time, and one of our personal favorites, graces PM's pages this month with an insightful piece on how we'll soon live on the moon. It's almost inevitable that we'll establish a permanent manned moonbase sometime in the next 25 years as a first step in a manned Mars mission. Asimov tells you how we'll do it beginning on page 66. . . . If you thought your next car would be powered by an electric motor, a turbine engine, a Stirling or some other exotic form of powerplant, sorry. Our "Car Of The Future" series turns its attention under the hood this month (page 53), and the conclusion is, well, kind of anticlimactic. Seems that your next car will still run on gas and still be an internal combustion engine. From there on, however, things *do* get exotic. Superchargers, fuel injection, five valves per cylinder, 12 cylinders—it'll all be there under the hood in 2001. You can read all about it, though, right now. . . . Speaking of things with wheels, it's just about time to come out of winter hibernation and get the yard and grounds in shape. Our outdoor power equipment roundup beginning on page 81 could contain just the item you need to make the job easier and more fun. . . . By the way, have you heard about the new gold rush taking place out west? Gold mines that were closed up years ago and abandoned as played out are once again yielding tons of gold thanks to new chemical technology that makes even low-grade ore fruitful to mine. The whole fascinating story begins on page 62. 'Til next time.



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THE ONLY TENSION YOU FEEL HERE IS IN THE ROPE.

Whether your notion of escape involves a ski boat, a run-about or a bass boat, the new Mercury 100 is without a doubt the perfect engine.

BUILT-IN PERFORMANCE AND DEPENDABILITY.

The four-cylinder in-line 100 is truly an engineering marvel. With astonishing low-end torque, a newly designed gearcase and larger cavitation plate, it pops up skiers, handles corners and planes

out superbly. Yet it can throttle back to a quiet 650-750 rpm for an afternoon of trolling.

In addition, it's been specially designed to dissipate heat easier for long engine life.

2 + 2 EQUALS SMOOTH OPERATION.

The new 100 boasts another Merc exclusive: "Concept 2 + 2," a feature that *automatically*

rolls the engine back from four to two cylinders when you're running at idle speeds. The result is cleaner, smoother, remarkably efficient operation.

Add the industry's only 3-year limited anti-corrosion warranty, and you can understand why the Merc 100 is being heralded as the engine that will not only live fast, but die old. No matter how you plan to escape.

MERCURY
OUTBOARDS

LETTERS

Keep On Vannin'

I WAS VERY pleased with your comments on the VW Vanagon GL Syncro 4x4 ("PM Comparison Test: Mass Transit," page 71, Nov. '87), but as an owner of a Syncro I'd like to see all those other "asphalt prima-donnas" challenged in a cross-country endurance race. I've driven into places where all the others would have to be dropped in by helicopter. Last winter, my Syncro outmaneuvered 4x4 pickups in the snow.

LOUIS MAGYARI
TJERAS, NM

All the vans you tested except the Vanagon were 2-wheel drive. You complained that "the Vanagon needs more horsepower." Why didn't you test a 2wd version which is more than 300 pounds lighter—it would have been fairer. I recently purchased an '87 Vanagon camper base model and find that acceleration is more than adequate for a vehicle weighing almost 3600 pounds.

MARK S. HAMMER
NEW HYDE PARK, NY

I was impressed with your evaluation of the seven vans in the "Mass Transit" comparison test, but did pick up one oversight: The Toyota van is also available with 4-wheel drive, contrary to your statement that the Vanagon is "the only van available with 4-wheel drive."

CHARLES D. NICHOLSON
LACROSSE, WI

We at Chrysler Motors Corp. read your minivan test with much interest. One item, however, does require some clarification: Reference was made (page 73) to a maximum towing capacity of 2750 pounds for the Dodge Cara-

van. This is true for Grand SE and LE models equipped with 3-liter V6 engine. But with an optional Trailer Towing Package for '88, maximum towing capacity is up to 4000 pounds.

H.J. KARP
MGR., S-BODY PROGRAMS
CHRYSLER MOTORS CORP.
HIGHLAND PARK, MI

Deep-Six

The engine in the Jeep Cherokee you tested in "Outdoors" (page 26, Jan. '88) is an inline Six, not a V6.

LARRY BLUE
POWVILLE, MD

Good catch. Boating and Outdoors Editor Joe Skorupa must have been daydreaming about V-shaped hulls.

Power For A Classic

Back in '65 I built the recreational 3-point hydroplane designed by Alan Scott from your plans ("Hydro Dynamic," page 144, March '68). It's marine plywood and mahogany and still in very good condition. The problem is my old Mercury 50-hp short shaft which is now reluctant to be repaired. New Merc 50s only come with long shafts, which won't work with this boat. Can you provide any ideas on adapting the boat to take the long shaft? I won't part with

my runabout. My grandchildren have been learning to water ski behind it and are looking forward to the coming season. EDWARD SIMEK
STERLING HTS., MI

Since the new outboards pack more punch, a 35-hp motor might perform well on your vintage boat. A Merc 35 is available in short shaft with manual-start tiller handle and remote-control electric start. Mariner has a short-shaft 40-hp model. If you still prefer a 50, try consulting a boat shop that can advise you about set-back plates that are based on transom strength, boat weight and so on. We've also got a Mercury Marine catalog in the mail to you to help you decide what to do. Glad you're keeping the old PM-designed boat afloat!

Rotary Club

In your "Car Of The Future" cover story in January (page 45), Lee Iacocca said the Chrysler minivan was a "home run" while the Wankel rotary engine really "never clicked." Let's remember that it was Volkswagen that introduced us to the minivan, and as for the rotary, if you consider the development time compared to the piston

engine, you'll have to agree that Mazda has done a terrific job. The RX-7 is quite a car. Maybe the rotary is not suitable for a bus, but it's a fine, smooth, reliable engine for a sports car that has proven itself on the track and the road.
GEORGE F. MOORE
NACOGDOCHES, TX

One For The Books

Your floor-to-ceiling bookcase plans (PM-1008, \$5.95 from POPULAR MECHANICS, Box 1014, Radio City Station, New York, NY 10101) were a great help in my design for the end wall in an addition to my house. I covered the 3-in. gap at the ceiling with a molding that is carried around the room for a professional appearance. I modified the bookcase facing to provide a little ornamentation.

ROBERT BARENSFELD
ELWOOD CITY, PA



Reader Barensfeld's bookcase wall is a variation on PM plans.

A TRADITION OF HORSEPOWER



Junior Johnson and Terry Labonte. The 1987 Budweiser NASCAR team.

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Published by The Hearst Corporation:

Frank A. Bennack Jr., President
Randolph A. Hearst, Chairman
Gilbert C. Maurer, President, Magazines Division
Richard E. Deems, Publishing Consultant

POPULAR MECHANICS is published monthly by the Hearst Corporation, 959 Eighth Avenue, New York, NY 10019, U.S.A. Frank A. Bennack Jr., President; Randolph A. Hearst, Chairman; Harvey L. Lipton, Vice-President and Secretary; Edwin A. Luciw, Vice-President and Treasurer; Hearst Magazines Division: Gilbert C. Maurer, President; D. Chasys Bahrenburg, Executive Vice-President; K. Robert Brink, Executive Vice-President; George J. Green, Executive Vice-President; Mark F. Miller, Executive Vice-President, General Manager; Raymond J. Petersen, Executive Vice-President; Thomas J. Hughes, Vice-President & Resident Controller; Daniel J. Coleman, Vice-President for Popular Mechanics.

INTERNATIONAL EDITIONS: CARIBBEAN, MEXICO, SOUTHERN HEMISPHERE

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TIME MACHINE

75 YEARS AGO: March 1913



Improving transport tech.

Economic Engineering

With the industrial revolution in full swing, attention was turning to the movement of goods in an increasingly global economy. Our cover showed a paddlewheeler churning the Mississippi adjacent to a complex lock, considered a pinnacle of early 20th century engineering. An inside article described the meticulous construction required in building the 46 locks of the Panama Canal, where metal-to-metal tolerances were often measured in fractions of an inch.



Lofting the military's new eye in the sky.

Early Birds

Aerial reconnaissance wasn't necessarily new. Nineteenth-century warriors had discovered the advantages of balloon-borne observation. But military scientists on the eve of World War I proved that recon could be accomplished without exposing the observer to hostile fire by using the newly developed "rocket camera." The device was launched from a portable track and the shutter automatically triggered when the rocket flamed out. A parachute returned the camera to ground operators.

50 YEARS AGO: March 1938



Steaming into the future.

Age Of Streamlining

In the panoply of post-art deco artifacts resides the Reading Railway's famed stainless-steel coal-burning locomotive, as sleek as later diesels. But beneath its rakish cowlung chugged a fairly standard steam engine of the period. Why the metal sheathing? Reading officials claimed the stainless steel repelled soot and cinders, a practical consideration to reduce cleaning time and expense. But the engine also made a statement about 1930s industrial design.

Bulletproof

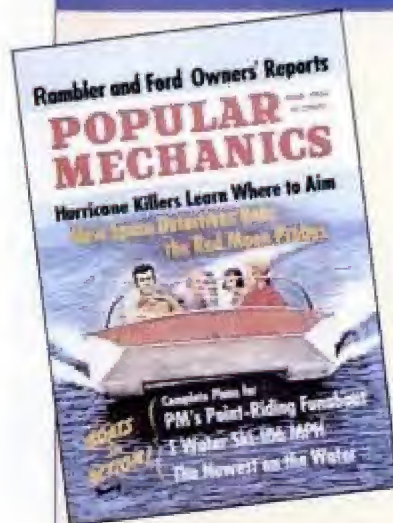
With the growth of 20th century society came 20th century problems—like gangland warfare. One company decided to fight back with an innovative bulletproof vehicle. Outside cladding absorbed bullets. Gunports pocked the

Designing for our urban security.



vehicle's exterior. And the inside was divided into three impregnable compartments. To top it off, designers incorporated a "comming tower," where a guard with a machine gun could scan 360°.

25 YEARS AGO: March 1963



Focusing on fun.

Anchors Aweigh

A recreation explosion was rocking America a quarter-century ago, ignited by a robust peacetime economy. PM kept in step with another special boating section in the magazine's long history of marine-related editorial. The focus this time was on family enjoyment and high performance, with articles on water toys and drag boats. All the diverse means of taking to the water, including the autonomous ski tow pictured, were presented to a fun-seeking readership. On the go-fast side, PM

presented "Golden Thing," a modified drag boat capable of on-the-water speed bursts surpassing 150 mph.



Getting wet.

Space Sleuths

The race for space was on and America was playing catch-up. The Soviets had lofted a series of Kosmos satellites while the U.S. perfected Project Mercury—and set its sights on the Moon. Engineers led by Donald J. Ritchie of Bendix Corp. were helping decipher Soviet space feats with the help of computer analysis of Soviet launches. His prediction? The Soviet Union would one day assemble interplanetary probes at space stations positioned in orbit.

Sound plausible?

PM

FOUR WHEELER OF THE YEAR.

Chevy's new 4x4 is off to a flying start.

Four Wheeler magazine has named Chevy's new full-size 4x4 the 1988 Four Wheeler of the Year.

Not because our big new 4x4 won its class at the Off-Road World Championships.* Or because it's the first all-new full-size 4x4 pickup introduced in this decade. But because the editors of *Four Wheeler* drove it. And loved it.

You can test drive that same Four Wheeler of the Year at your Chevy dealer's.

Do it and you'll feel the winning edge in power from a fuel-injected Vortec V6 with 15 more standard half-ton horsepower than Ford. Feel the precision of the standard 5-speed manual transmission with overdrive. Feel the ease of shifting on-the-fly with Insta-Trac that's also standard. Feel the smooth ride of the double A-arm independent front suspension system.

Test drive a new Chevy full-size 4x4 pickup and you'll feel quality built to last. Quality built to win.

*Race-modified 4x4 sponsored by GM Parts and outfitted with required safety equipment.



GM 6/60 Let's get it
together.
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of body-rust-through protection. Solid proof of the
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Heartbeat
OF AMERICA



TODAY'S CHEVY TRUCK

This One



B19F-46Q-80U2

Illustration by [illegible]

ELECTRONICS

BY STEPHEN A. BOOTH

Reach Out And Touch . . .

IN THIS REALM of electronics, it sometimes seems to me that barely a quartz-regulated minute goes by before today's innovation is yesterday's news. Let Company A announce something new and it's even-money that Company B will up the ante—if not trump the lead altogether. Why only last month, this column reported on the new and affordable home videophones by Mitsubishi and Sony ("Electronics," page 50, Feb. '88). Those phones, you'll recall, can transmit and receive black-and-white still pictures over a conventional voice line. You might have guessed that living color would come next—and you'd be right. Sanyo, in Japan, has, in fact, demonstrated a videophone system capable of rendering color images. Had you guessed color and motion weren't far off, you'd be right on the money, too. An Irvine, California-based firm has developed



The U.V. Communicator sends full-color motion video over regular phone lines.

just such a better mousetrap. The company is called Universal Video Communications Corp. and it calls its product the U.V. Communicator. No, you can't go out and buy one now. Fact is, you'd need two to have a colorful, moving conversation, and each U.V.C. costs about \$15,000 today. That kind of money warrants Fortune 500 companies for customers,

but if you do have the wherewithal you'd better place an order fast: The manufacturer says production will be limited to about 60,000 units this year. And while you're ordering you'd better get the phone company to install a few extra lines for you, because the U.V.C. needs at least two to work and four for top performance.

How does the U.V. Communicator work?

You can't tell from the outside, which shows not much more than a telephone, plus a videocamera perched atop a monitor. It's the "black box" upon which the monitor is perched that holds the answer.

As you might recall, there isn't a lot of bandwidth in a voice line to accommodate b&w stills, let alone color motion video plus audio. With the U.V.C., one line is dedicated to audio, and the other line or lines (up to three) carry the video. Because up to 85 per-

cent of a motion picture is stationary, and thus redundant, the U.V.C. system only transmits the 15 percent that is in motion. Computer-generated frames fill out the rest. As for the motion part of the picture, the real-time speed of the movements depends on the number of lines used to transmit the video. The more lines, the more lifelike the movements. But even with a single phone line for video, computer-generated frames provide the viewers with a perception of smooth motion. Stay tuned for more on the U.V.C. and

similar systems certain to emerge!

Man Bites Dog

Given the look-alike putty color of their products, it seems most computer makers have swallowed wholesale Henry Ford's dictum that "you can have it in any

(Please turn to page 15)

World Series Files Filmless Photos

THE TWO photos reproduced here, taken in Minneapolis at the second game of last fall's World Series, are the first color pictures of a news event to appear in a U.S. publication using an electronic magnetic disc camera instead of conventional film. The images ran on page one of *USA Today's* October 19, 1987 edition, and were made with Canon's Still Video System—then transmitted to the paper's newsroom via telephone lines. This helped pictures from the night game make the morn-

ing newspaper's first edition deadline.



Paint it black? No need to, as Delta computers come that way.

The world's first do-it-yourself print ad.

Close your eyes and imagine the most flavorful picture you can.
Now, think "Merit." Congratulations! You've created the perfect Merit ad.
Because flavor is what Merit is all about. Merit Enriched Flavor™ delivers
real smoking satisfaction with even less tar than leading lights.
So thanks for your help. You created the perfect image for Merit.
And you saved us a bundle on expensive photography.

Enriched Flavor,™ low tar. A solution with Merit.



**SURGEON GENERAL'S WARNING: Quitting Smoking
Now Greatly Reduces Serious Risks to Your Health.**

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Kings: 8 mg "tar," 0.6 mg nicotine av. per cigarette by FTC method.

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A DASH OF GOOD LOOKS.**

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Let's face it, you probably didn't buy your American car because you loved the stereo that came with it.

Which left you with only two choices. Either put up with that dashboard eyesore, or replace it with another unit that stuck out like a sore thumb. It was enough to drive you crazy.

That's why Pioneer proudly introduces their newest concept in car stereos—Auto America™.

Their sleek, futuristic styling and high-tech controls fit right in with today's American dashboards. And thanks to Pioneer's exclusive shaftless design, shorter mounting depth, and flush edge-to-edge fit, they won't stick out of your dash—or even worse, leave a hole in it.

As for the music they make, they're pure Pioneer, so you know you're getting the most beautiful sound on the road.

Auto America by Pioneer. The first car stereos you'll be proud to put in your American dash.

PIONEER

Auto America units available: KE-4060, KE-4060 Quick Release, KE-4010, and KE-4010 Quick Release. Optional graphic equalizer stacking kits also available.
© 1988 Pioneer Electronics (USA) Inc., Long Beach, CA

ELECTRONICS

(Continued from page 12)



New, flat motor the size of a half-dollar lets Sanyo build cassette-size portables.

color so long as it's black." Well, someone has finally broken the color line in "plain vanilla" computers by offering machines that actually are black.

The cosmetically unique computers hail from Delta Computer Corp., Mansfield, Massachusetts, and travel collectively as the Deltagold line. They're quite attractive: The 2-tone charcoal black chassis is accented by soft gray and gold pinstripping.

Of course, you don't buy a computer just for good looks. This IBM-compatible line offers all the features you'd expect to find in other PC-clones, and offers a range of price/performance options. This begins with the basic Elite at \$1195, carries through on the Prestige (\$1995) all the way to the top-of-the-line Premier at \$4995.

Slim And Trim

It isn't often that we get to talk about the mechanical aspects of a consumer electronics product, but the motor in Sanyo's line of Sportster headphone stereos warrants comment because it enables the company to manufacture portables that are no bigger than a typical cassette case.

The new motor, which handles the tape transport functions, is about the size of a half-dollar coin. Sanyo uses a flat-coil winding design that nets a downsized motor with no loss in performance or efficiency. More remarkable



"Intelligent" steering wheel, from Rinspeed and Blaupunkt, controls car stereo, phone.

still, the flat-coil motor takes its power from a new, rechargeable NiCd cell that provides up to 15 hours of juice. The AC adapter that comes with the Sportsters lets you use household current to power the players—while at the same time recharging the built-in battery.

Steer-By-Wire

Actually, the intelligent steering wheel from Blaupunkt lets you operate some of the company's car stereos and car telephones by wireless, infrared remote control. As such, it's just the thing you want while you're hanging Gs on a mountain road to the accompaniment of Mozart or Motown.

The smart wheel (\$995) is the result of a joint venture between Blaupunkt, of car stereo fame, and Rinspeed, a Swiss company best known for equipping Porsches and other hot cars with new identities—including interior, body and engine. The new wheel, based on an Italian-made Momo design, has a 24-button control pod to operate the various functions of Blaupunkt autosound radiocassettes, CD players and cellular mobile radiotelephones.



Battery-powered portable transmitter lets photogs file filmless photos by phone.

Loose Canon

The new technology of filmless, electronic still video cameras has already freed news photographers from the darkroom. Now, a portable, battery-powered telephone transmitter from Canon will help them get their pictures to the paper on deadline without ever having to enter the newsroom.

Canon's RT-611 still video transmitter (\$12,000) lets the photog file his magnetic-disc pictures from any telephone, anywhere. It weighs about 8 pounds and sends a color photo in 3½ minutes—1½ minutes for black and white.

The photographer can see the images as they're being transmitted, thanks to the RT-611's built-in TV screen. It either connects to the phone by a modular jack, or to the phone's mouthpiece through an acoustic coupler. How's that for talking pictures?

PM

FREEWHEELING

BY TONY SWAN

Tokyo '87: A Feast For Technovores

OVER THE course of the last decade, the Tokyo Motor Show's mind-boggling array of concept cars and fantasy engines has become an event no serious carbiz-watcher can miss.

The show's 27th renewal, continued this tradition. Some noteworthy creations: **■TOYOTA**—Though they were conservative, Toyota's concept cars had lots of subdermal Sci Fi, such as a turbine 2-seater.

But the *piece de resistance* was the FXV-II, whose components read like a spec sheet for the next decade: conductive ceramic antennas and window defoggers, polarized crystal canopy with light-intensity control, radar cruise control, active air suspension, electronic 4ws, full-time 4wd with viscous-coupled limited slip, automatic traction control, ABS, tire pressure warning, and a 4-cam 32-valve aluminum V8.

■NISSAN—There were seven Nissan concept cars, including an update on the Mid4 sports car.

But it was Nissan's concept engines that foretold the next century. Mixed in with familiar hardware was a ceramic turbo with a plastic compression impeller running in ball bearings. Valves on this engine were ceramic and the 2-ring pistons were compression variable.



Subaru's colorful Jo-Car was one of several automotive fashion statements at the show.

■MAZDA—The star here was the MX-04, a modular car that could become either a coupe, roadster or bare bones runabout.

■MITSUBISHI—Two new production cars—Galant (4wd, 4ws, 2.0-liter dohc 16-valve intercooled turbo Four) and Mirage (1.6-liter dohc 16-valve intercooled turbo Four)—stole the show.

■SUBARU—You expect other-worldliness from Subaru, delivered here by the F624 Extremo. Included in this strange,

slightly bulbous 4-door was a new continuously variable transmission (CVT), full-time 4-wheel drive with continuously variable front/rear torque split and 4ws. Suspension was electropneumatic, the variable-assist steering was electric (no hydraulic pump), and braking was ABS.

Power came from a 24-valve intercooled twin-turbo version of the Subaru 2.7-liter flat Six.

And there was much more: Daihatsu's TA-X80, a 2-seat

mini-midi with a 1.0-liter twin-cam 24-valve turbo V6. Some tiny urban sportsters from Suzuki. A pop-top 2-seat ATV from Isuzu.

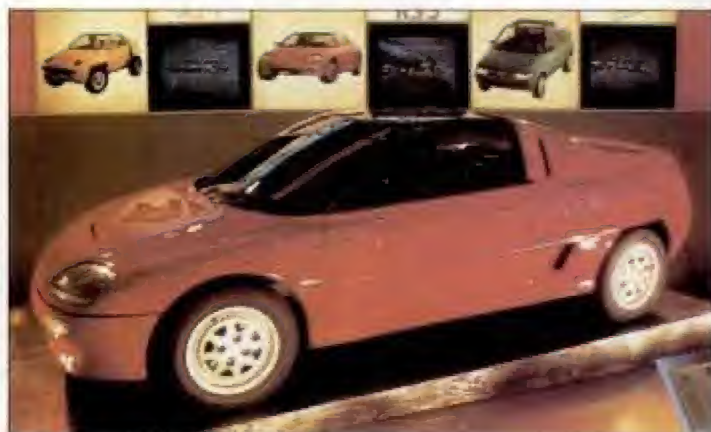
But amid all the techno-excess, Honda made the case for powertrain superiority.

Surrounded by an armada of dream cars, Honda showed only production models—punctuated by Formula One cars and engines.

By Tokyo Motor Show standards, the message was subtle. But we'll bet no one missed it. **PM**



Isuzu's mid-engine COAIII: 21st century ATV.



Suzuki's RS-3 packs motorcycle punch in a bite-size street tiger.

PM TECH UPDATE

MARCH

1988

NASA Tailors An Off-The-Rack Spacesuit

MOFFETT FIELD, CA

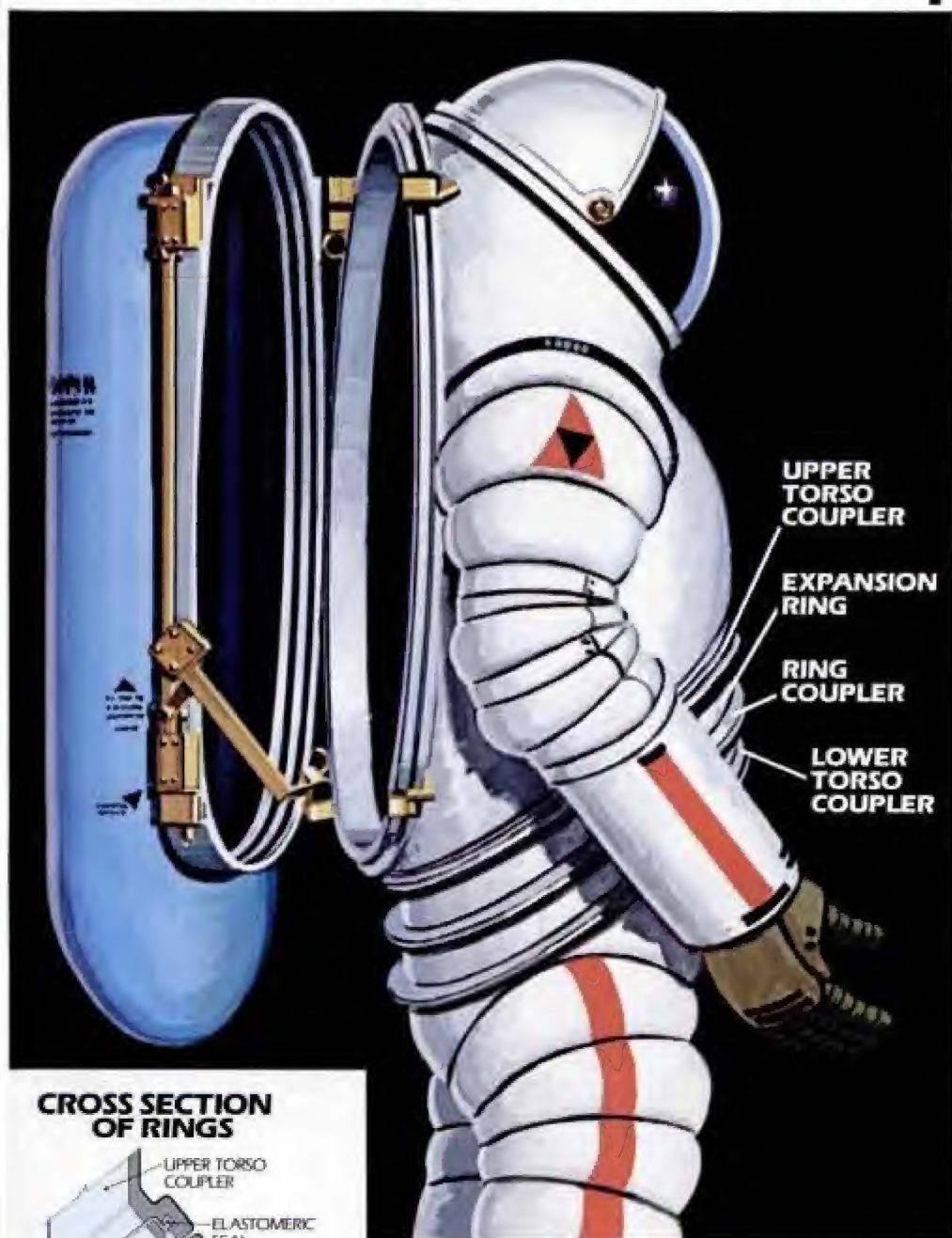
NASA has always wanted to get more mileage out of its custom-designed, nonreusable spacesuits because they cost hundreds of thousands of dollars apiece.

The solution? Hubert C. Vykukal of NASA's Ames Research Center has invented a hard spacesuit with an adjustable-length torso portion, permitting different-sized astronauts to use the same suit. According to the inventor, one suit can accommodate anyone from a 5-ft. 2-in. 100-pound woman to a man taller than 6 ft.

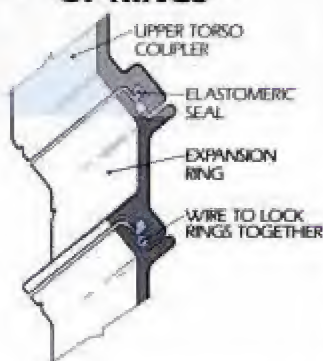
Depending on an astronaut's size, one or more expansion rings can be coupled between the upper and lower portion of the suit. For the smallest sizes, the two main sections can be connected directly by fitting the coupler of the upper torso section over the corresponding coupler on the lower section.

The rings themselves have the same coupler arrangement on their upper and lower edges. That is, the two facing surfaces of each mating pair have matching grooves. To hold them together, a flexible cable or wire is inserted. Elastomeric padding between the rings and couplers form a pressure-aided hermetic seal. The rings slant upward and forward to accommodate an opening through which the astronaut enters the suit.

The entire suit, which is machined out of aluminum, weighs approximately 185 pounds. This same design is also suitable for deep-sea diving. Softer versions, which could be used in industrial-hazard cleanup work are also feasible.



CROSS SECTION OF RINGS



Two expansion rings are shown in above illustration. Astronaut enters upper torso section of suit through opening in back. A backpack that houses life-support and communications equipment closes off the opening. The rings slant upward at an angle of about 50° to allow for backpack opening. At left, cross section shows coupling mechanism and matching geometry of rings.

Editor: Tim Cole
Assistant: Gregory T. Pope
Contributors: Mike Fillari, Nick Nichols



ABS braking, computerized suspension and So does the ride of your life.

Few cars on the road come as well equipped to handle a demanding driver's needs like this one. The Thunderbird Turbo Coupe. Its power. Its poise. The strength and intelligence of its design. All add up to a world class automobile that's won praise from critics the world over. Thunderbird Turbo Coupe. Take it

for the sheer joy of driving. Take it for the ride of your life.

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Based on an average of owner-reported problems in a series of surveys of '81-'87

models designed and built in North America. At Ford, "Quality is Job 1."

Ford Thunderbird Turbo Coupe.

Have you driven a Ford...lately?



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TECH UPDATE

MARCH 1988

Silicon Blood Chip



LONDON PICTURES SERVICE PHOTO

Chip monitors blood ions.

TYNE, ENGLAND

—Blood diverted from a patient's arm during surgery passes through this tiny assembly. Inside, a silicon chip reacts electrically with ions in blood and sends signals to a computer monitor, giving anaesthetists a look at sudden changes in blood chemistry.



MCDONNELL DOUGLAS ILLUSTRATION

Vanes over nozzles help F-15 S/MTD land on damaged airstrip as short as 1250 ft.

High-Maneuverability F-15

ST. LOUIS, MO

—Labeled S/MTD (for Short Takeoff and Landing and Maneuvering Technology Demonstrator), this fighter is designed to operate from bombed-out runways without sacrificing performance.

Aided by venetian-blind-like vanes above and below the nozzles, the plane's engines will be able to reverse thrust to sharply reduce speed, enhancing maneuverability and short-takeoff attributes.

The plane also features a

computer-coupled radar system that analyzes potential landing sites on a cratered runway.

The 1-year test program is aimed at the development of technologies for the next-generation F-15 Eagle and the Advanced Technology Fighter.



PM ILLUSTRATION BY ED VALIGURSKY

TOPEX/Poseidon will take near-polar orbit at an altitude high enough to minimize atmospheric drag.

Mapping Oceans From Space

PASADENA, CA

—The closest look yet at the shape of the sea will come from 830 miles above Earth. The joint U.S.-French satellite TOPEX/Poseidon is now scheduled for a 1991 launch on the European Space Agency's Ariane rocket.

On board, a NASA radar

altimeter will bounce signals off the ocean's surface. The variations in sea-level height indicate currents, eddies and other components of ocean circulation, as well as sea-floor features.

Pinpoint accuracy distinguishes TOPEX/Poseidon from previous sea-mapping satellite missions. The altimeter

will operate at two frequencies to counter interference from electrons in the ionosphere. A laser/radio tracking system will locate the satellite's distance from Earth with a margin of error of only 5 in. And a microwave radiometer will calculate radiation emitted by water vapor and correct errors the vapor induces in the altimeter.

TOPEX/Poseidon effort

will help answer questions about El Niño, the capricious periodic warming of the Pacific Ocean. Another focus will be how currents influence the ocean's absorption of atmospheric carbon dioxide. Mission data will also contribute to weather and climate prediction, and to the engineering of off-shore oil rigs and coastal powerplants.

THE STRIKING NEW COBRAS

**Designed
without the coil, or the hisssss!**

The new Cobra cordless phones are unlike anything you've seen or heard before.

With sleek, European styles and colors. Plus curved, comfortable handsets.

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DYNASCAN CORPORATION



TECH UPDATE

MARCH 1988

Space Station Underway

HUNTSVILLE, AL —NASA contract-winner Boeing Aerospace has embarked on the task of designing and building the Space Station Laboratory and Habitation modules. But now, visitors to the Marshall Space Flight Center can get a glimpse of mid-1990s space



Employee pulls out Space Station's mobile workbench.

life: Full-scale mockups already exist for crew-member training, operations support

and as engineering aids.

Both cylindrical modules are about 44 ft. long and 14 ft.

in diameter. At one end of the mockup in the life science area is a 1.8-meter centrifuge and storage racks for plants and animals. In space, this will create artificial gravity for animal habitat and plant experiments.

At the front end of the habitation module are quarters for up to eight astronauts. There is also a health maintenance facility to let the crew monitor vital signs and take X-rays and blood samples.

Still under preparation are mockups of the Station's logistics module and interconnecting nodes.

NASA PHOTO

Robotic Lineman



Safe in his truck, a teleoperator repairs line by remote control. PHILADELPHIA, PA—TOMCAT (Teleoperator for Operations, Maintenance and Construction Using Advanced Technology) is designed to take the danger out of overhead transmission line repair.

Wielding a manipulator arm similar to those used in Shuttle missions, TOMCAT is guided with a video camera by an operator in a truck. The manipulator has the same degree of freedom as a human hand, plus continuous 360° wrist rotation. Once led through an operation, the manipulator repeats movements forward or backward.

Designed by Kraft Oceanic Systems to operate underwater, the manipulator can also work in water-filled manholes and other wet environments.

Utilities have already tested prototype TOMCATs, changing insulation on live high-voltage lines and cleaning transformers in nuclear plants.



This MOTR unit can track 10 targets simultaneously.

Multitarget Test Radar

WHITE SANDS, NM

—This radar system, the first of its kind, combines a new electronically steered phased-array antenna, a high-power transmitter and a Defense Department-caliber minicomputer.

Called Multiple Object Tracking Radar (MOTR),

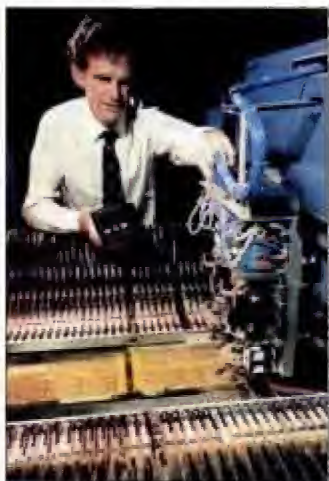
the equipment may beef up instrumentation at test-range facilities. RCA Aerospace says its MOTRs can locate several targets at once more accurately than the best combination of existing single-target radars. The technology has implications for battleship defense.

Steady Cool

WORTHING, ENGLAND

—Temperature control during manufacturing is essential for goods as diverse as steel, processed food, semiconductors and false teeth.

Eurotherm Ltd. says its temperature controllers eliminate a major manufacturing headache—maintaining the temperature after the process has been modified. A microelectronic adaptive tuner feeds back on the controller to ensure control. The device may remove research-to-production hurdles.



"Smart" temperature control.

LONDON PICTURES SERVICE PHOTO

RCA AEROSPACE PHOTO

PM ILLUSTRATION BY ED VALIGURSKY



FAMILY FUN TO GO

\$9435*

...and even the trailer is standard!

To Bayliner, complete means a fully-equipped boat, performance-matched engine and custom-fitted trailer...all at one truly affordable price.

The 1750 Capri Bowrider is one of nineteen Bayliner Total Value Packages for 1988; it delivers lively, economical performance, great looks and a boat load of features, like AM/FM cassette stereo, complete canvas, custom swim platform and deluxe appointments throughout. The durability, serviceability and corrosion protection of OMC Cobra® stern drive power is standard.

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Bayliner pioneered the idea of com-



1750 Capri Bowrider

plete, affordable boating outfits...and for 1988 we offer no fewer than nine of them at less than \$10,000*. All built with the kind of quality that has made Bayliner the hands-down value leader...and the world's largest boatbuilder.

With Bayliner, it's easier than ever to get into the fun of boating. And a big part of the fun is knowing you've bought the best.

Your Bayliner dealer has the details. Find him in the yellow pages, or write for the name of the dealer nearest you.



*Manufacturer's suggested special pre-season price in effect at participating Bayliner dealers. Actual prices set by dealer. Taxes registration, freight, options and dealer prep charges extra. Prices may change without notice.

Yes, I'd like to know more about Capri value for 1988...please rush me the name of my nearest Bayliner dealer.

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BAYLINER

TECH UPDATE

MARCH 1988



IBM PHOTOS



Testing apparatus dwarfs chip (left) that contains ultratiny transistors (above), enlarged 10,000 times.

World's Tiniest Transistors

YORKTOWN HTS., NY
—Transistors can't get much smaller than these, a tenth of a micron wide—1000 times thinner than a human hair. The IBM research group that made them had to operate them in liquid nitrogen, -320° F, because at room temperature the voltages needed to switch the transistors would fry them. Yet the signal the transistors sent was the most powerful ever measured for devices their size.

The electron-beam lithog-

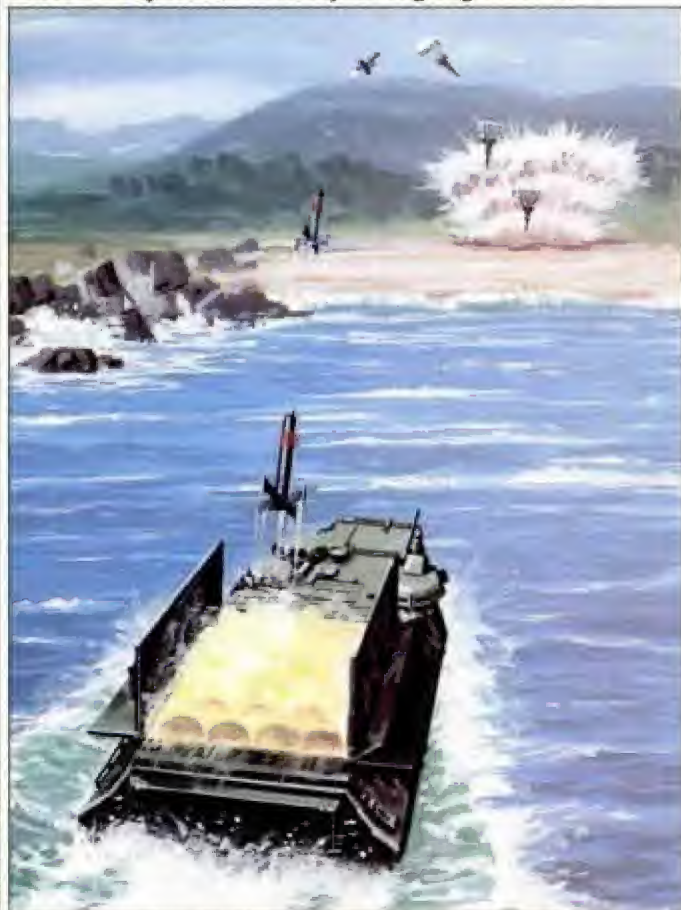
raphy equipment that carved the transistors' features is capable of even finer work—electrical conductor lines $\frac{1}{10}$ th of a micron wide. Logic chips made entirely of $\frac{1}{10}$ th-micron devices would operate at speeds 10 times faster than today's best chips. According to IBM, such performance would enable main-frame applications like weather forecasting and continuous speech recognition to run on machines no bigger than personal computers.

Busting Beach Defenses

EGLIN AFB, FL—When the U.S. Marines hit the beach in an amphibious assault, one of their biggest headaches is clearing enemy mines—a nerve-wracking process that makes gaining ground a game of inches.

All that is about to change with the introduction of FMC's Catapult-Launched Fuel-Air Explosive (CATFAE) system. The heart of the concept is a 21-cell rocket pod that fits snugly into the troop compartment of the Marines' AAV7A1 amphibious assault vehicle. The rocket itself is a Honeywell development. Its detonation in the minefield creates a tremendous level of overpressure that sets off or neutralizes both antitank and antipersonnel mines.

The 21 CATFAE rounds carried by each vehicle can clear a swath 20 yards wide $\times$ 300 yards long. And once the Marines have landed, CATFAE can be put to use clearing inland minefields. The system is currently undergoing field trials.



Launched from well offshore, CATFAE can breach a minefield in less than a minute.

PM ILLUSTRATION BY ED VALIGURSKY



NASA ILLUSTRATION

X-rays can't pierce our atmosphere, so AXAF will work 320 miles up.

Detecting X-Rays From Space

HUNTSVILLE, AL
—Sometime in the mid-1990s, this 15-ton observatory will go into orbit. This year NASA will pick either TRW or Lockheed to build the vehicle, designated AXAF for Advanced X-ray Astrophysics Facility.

Essentially a 15-ft. $\times$ 50-

ft. cylinder, AXAF will probably go up on the Space Shuttle. Mirrors at one end will be angled so that X-rays skip off them and hit four imaging detectors at the other end.

AXAF will help answer questions about black holes, quasars and the birth of the universe.

Mixing Beams

PRINCETON, NJ
—Customized semiconductor materials are possible with molecular-beam epitaxy apparatus. Inside, separate furnaces vaporize atoms of gallium, arsenic, aluminum and the additives that boost electron conduction. Each furnace generates its own molecular beam. The beams all focus on a substrate and deposit semiconducting material in layers only a few atoms thick. By adjusting shutters in front of each furnace, researchers can concoct semiconductors for different applications. It has already yielded gallium arsenide transistors compatible with silicon chips.



Molecular-beam epitaxy for mixing semiconductors.

SEMENS PHOTO

TECH UPDATE

MARCH 1988

Comet Penetrator

ALBUQUERQUE, NM
—This instrument-laden missile will fire by remote control from NASA's unmanned Comet Rendezvous Asteroid Flyby (CRAF) spacecraft, scheduled for launch in 1993. The 5-ft.-long titanium Comet Penetrator-Lander is designed to hit at 90 mph and plunge 3 ft. into the comet's icy core.

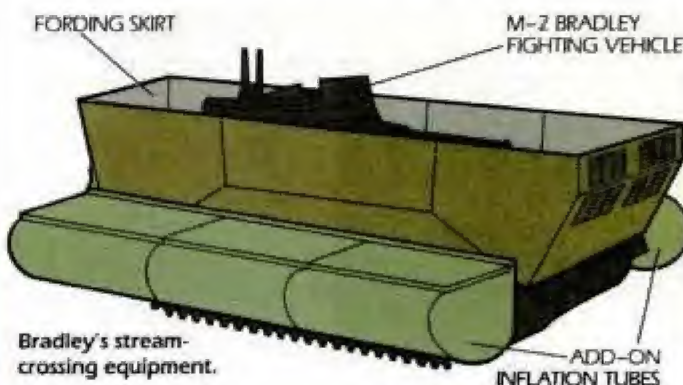
Jutting from the Penetrator's side is a tooth that will scrape off some comet ice and guide the sample into a thimble-sized container. There, a miniature heater will melt the ice, mimicking the Sun's action. Scientists will thus have a close look at the chemical changes that occur as the comet swings around the Sun. Other instruments will analyze the gases that evolve to cloud the comet as the Sun warms it.

The probe will give insight into the origin of comet ice—especially whether it was made during the formation of our solar system.



Elongated golf-tee design to pierce comet even at bad angles.

Bradley's Swimming Upgrade



Bradley's stream-crossing equipment.

ABERDEEN, MD
—Army engineers have been working on an improved flotation system for the controversial M-2 Bradley Infantry Fighting Vehicle: an airbag-type device to supplement the Bradley's existing 3-ft. fording curtain. Inflation tubes will be fitted beneath

the vehicle's protective armored skirts, where they will be filled in under 4 minutes by an air blower. Crews can deploy the system without leaving the safety of the vehicle. It should float the personnel carrier high enough to allow error-free use of the vehicle's fording skirt.

Digital Fingerprinting

WHITE PLAINS, NY
—Your ultimate identification is at the tips of your fingers, but how do you load it into a computer? A system developed by Fingermatrix, Inc. addresses the problem.

An infrared camera photographs uninked fingerprints, cutting through grime. The image is digitally stored. Software identifies and indexes the prints based on position of the minutiae—indi-

vidually unique ends and forks in fingerprint ridges.

The system has police, credit-card and security applications.



Yellow points are minutiae that aid retrieval of computer-stored fingerprint images.

Recycling Shuttle Fuel Tank

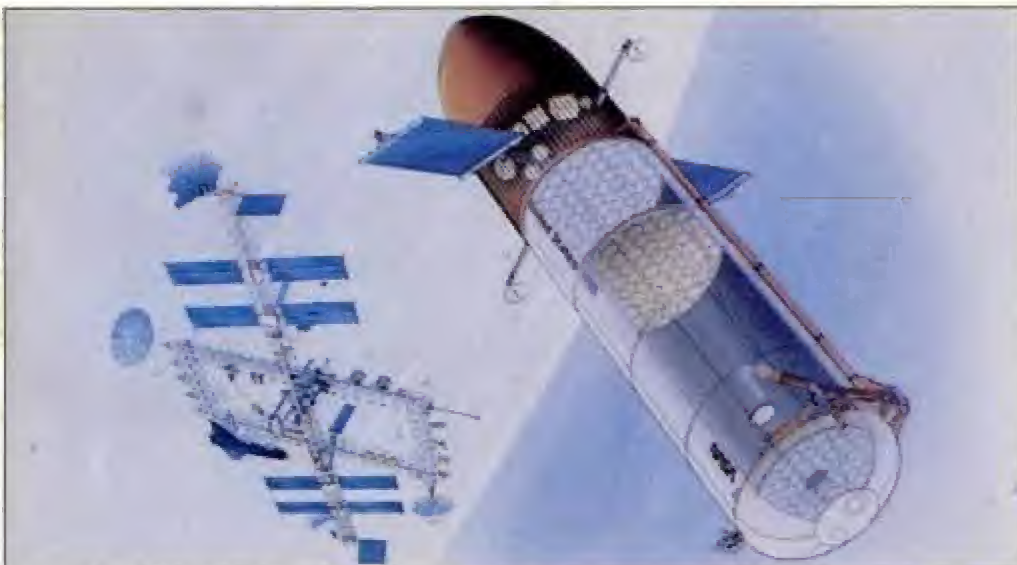
HUNTSVILLE, AL
—Researchers at the Marshall Space Flight Center and Martin Marietta have been

exploring other uses for the Space Shuttle's huge external tank, such as conversion into a habitation module.

One alternative involves putting the tank into orbit and converting it into a permanent gamma-ray telescope, known as GRITS. One flight would put both the Shuttle

and tank into orbit. The fuel would be burned up, leaving the housing for the telescope. The components and other support devices needed to make the telescope would be launched on a separate flight.

Upon rendezvous, the Shuttle astronauts would strip out some of the tank's internal fittings to allow gamma-ray penetration, then outfit the tank with a water-inflated, thin-film lens package. They'd also have to disconnect the tank's liquid-fuel siphon and baffle assembly to clear the telescope's field of view. NASA researchers have run through these tasks immersed in Marshall's 40-ft.-deep Neutral Buoyancy Simulator. If GRITS proves practical, NASA will get more use out of its launch package.



Instead of plunging into the Pacific Ocean, Space Shuttle tank becomes gamma-ray telescope.

CAR CLINIC

BY MORT SCHULTZ

Treating Smelly A/Cs

THE AIR conditioner in my 1985 Ford Tempo gives off a vile odor. The system was deodorized, which did no good. Then I replaced the evaporator. This helped for awhile, but it sure is an expensive temporary repair. Is there a better way?

HOWARD SCHINELLER
DELRAY BEACH, FL

If there is, it's with a brand-new product that is now available through Mr. Goodwrench (GM) and Motorcraft (Ford) channels. GM calls the treatment "Goodwrench Air Conditioner System Disinfectant." Motorcraft refers to it as "Motorcraft A/C Odor Treatment Kit." The developer of the product, Alcide Corp. of Norwalk, Connecticut, calls the decontaminating agent "RenNew-A/C."

The treatment is the only one presently available that kills the mold spores which create the odor and also cause distress to those suffering from asthmatic and other bronchial ailments. Deodorizers mask the odor—they don't kill the spores. Mold spores take root and spread in the moisture on the outside of the evaporator. Moisture develops as the evaporator gives up heat from the refrigerant that circulates through it. Replacing the evaporator will rid you of the infestation on that evaporator, but there's no guarantee that moisture and mold won't form on another evaporator. Drivers in the warm, humid southern parts of the U.S. where air conditioners are in use practically full time are more at risk than those residing in other areas. Although there are plans to

sell the treatment to other new-car manufacturers and independent a/c shops, you probably won't be able to find it yet at any but Ford and GM dealers. Can you do it yourself? Sure—if you have the necessary spraying equipment, which costs in the \$300 range. I better warn you that one treatment may not be enough. It's more like one treatment whenever you get a recurrence of the odor. Depending on where the car is being operated, that could be once a year or more.

Real Rich

Since the day I bought my 1986 Pontiac 6000 LE, its 2.8-liter engine has been very hard to start after the car has been driven and then parked 2 to 4 hours. There is a strong smell of gasoline, too. The service manager at the dealership claims this is all normal—that the long cranking is the fuel injectors' way of clearing themselves.

Do you agree?

WILLIAM HOSEK
COLUMBIA, SC

The service manager is apparently not familiar with Pontiac technical service bulletin (TSB) 86-6-71. Other 1985 and 1986 GM models equipped with the 2.8-liter engine and multiport fuel-injection systems are dealt with in similar TSBs.

Although the TSB doesn't mention it, hard starting is a result of tiny particles which were left in one or more of the fuel injectors during the manufacturing process. These keep the injector pintle open when the engine is turned off. Over the course of a few hours, enough gas drips from the injectors to flood the engine and cause hard starting and gasoline odor.

The TSB recommends that the dealer test each fuel injector and the cold-start valve for leakage. If the leak-down rate is one drop or more per

minute, he should replace that injector or cold-start valve. The cost of repair should be on the house.

Ode To A Code

The 2.2-liter engine in my new 1987 Plymouth Sundance idles very fast even after it's warmed up. If I don't put the transmission into Neutral when I'm stopped at a traffic light, the car keeps edging forward even though my foot is on the brake—that's how bad it is. The dealer installed a new fuel injector and a new computer before giving up.

Is there a way to tone down the idle? He says no. The car has been driven 16,000 miles to this point.

RICHARD BLY
MONTPELIER, VT

The Chrysler Corp. 2.2-liter engine should idle at 1200 to 1400 rpm when it's cold, and about 800 rpm after it's warmed up. "Very fast" is too fast. What can you do about it? Just this.

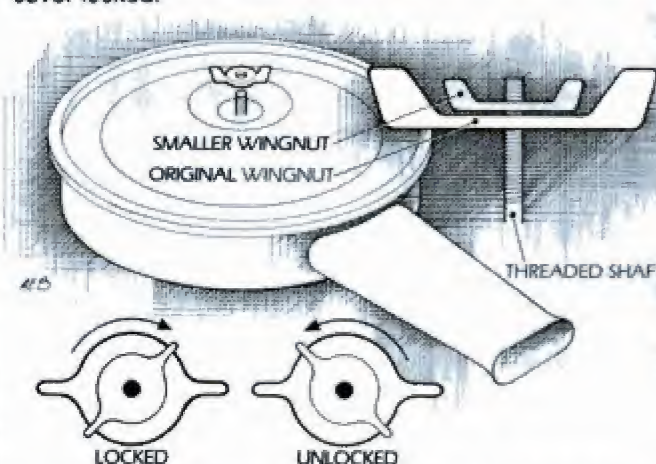
First off, realize that idling speed is controlled by the computer based on data it receives from various sensors. Replacing the computer isn't going to do one bit of good if a sensor is feeding the wrong information to the computer. Incidentally, your engine actually has two computers—a logic module that assimilates and analyzes data and a power module that carries out the commands of the logic module. The three key sensors in this system are the coolant-temperature sensor, vehicle-speed sensor and throttle-position sensor. Your dealer should have literature called "2.2-Liter Engine Driveability Test Procedure" that is distributed by Chrysler. If he doesn't, he should get one from the home office. It's a step-by-step guide on how to go about finding out if one or more of these sensors is out of

(Please turn to page 28)

Winging It

Here's a wing-ding of an idea from Andrew Traylor of (503 Cain Ridge Rd.) Vicksburg, MS (39180). He writes, "After installing an aftermarket air filter on my Toyota, I found the wingnut atop the carburetor would slowly work itself loose. Several tightenings crushed the element, and it had to be replaced."

To keep this from happening again, Andrew got a wingnut that was smaller than the air cleaner cover wingnut. He put a new element in the housing, placed the cover over it, put the smaller wingnut inside the larger original wingnut, and carefully screwed them down together. The smaller wingnut keeps the larger wingnut and, consequently, the air cleaner cover locked.





BE SURE YOU PICK THE RIGHT ONE. IT'LL BE AROUND AN AWFULLY LONG TIME.

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CAR CLINIC

(Continued from page 26)

synch. But heck, you can practically do it yourself. Let me tell you how.

Behind the wheel, turn the ignition

switch On-Off, On-Off, On, without cranking the engine. With that last On turn, leave the switch on. Watch the dash. An engine diagnostic light should come on.

(It's a lot of "Ons," I know, but they're

all necessary to check whether or not the sensors are working in synch.)

The light should glow for a few seconds and then start to pulsate. If it pulses five times, pauses and pulses five times more (code 55), there's nothing wrong. If you get a different code, determine what that is by the number of pulses before and after the pause. Check the service manual for the lineup of codes. This will indicate where the computer thinks the fault lies—that is, with what sensor or with which sensor circuit.

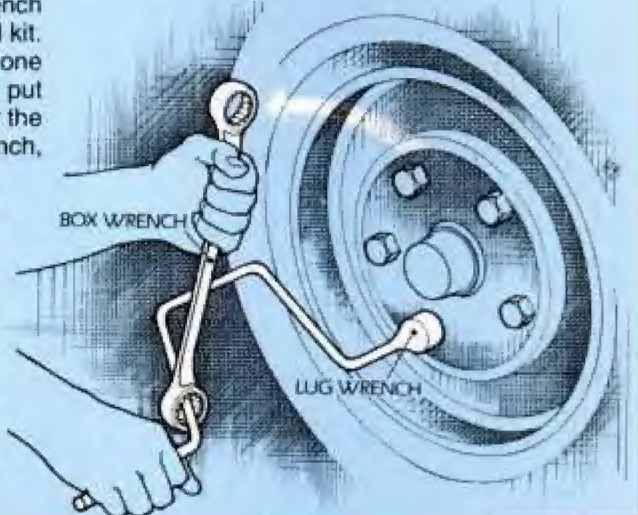
But the fault doesn't have to lie with a sensor or its circuit. No, I'm not double-talking. Based on the data it gets from the sensors, the logic module orders the power module to instruct the automatic idle speed (AIS) motor to set engine idling speed. Therefore, the guilty member of the team could very well be the AIS motor.

The AIS motor adjusts the idle by means of an air bypass on the throttle body. The motor opens or closes the air bypass to increase or decrease the amount of air called for by the engine as it encounters differing load and ambient conditions. If the AIS motor is out of tune and adjusts on the high side, the idle will be too fast.

A quirky AIS motor circuit will show up as a trouble code, but a faulty AIS motor will not. So dismissing the AIS

You Big Lug

Just when you need it the most, suppose your strength fails—like when you go to replace a flat on a desolate road and find that some garage you had trusted your car to rammed the lug nuts home so tightly your wrench is no match. Try this: Take a box-end wrench from your in-trunk tool kit. (If you don't have one there now, why not put one there.) Slip it over the handle of the lug wrench, as shown in the illustration, and push the box-end back against the lug wrench. The extra leverage from adding the wrench will help considerably, but the big advantage is in being able to pull up with one hand while you push down with the other.



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motor as the reason for too fast an idle just because a trouble code isn't obtained is a bad step. The AIS motor should be tested according to the "Driveability Test Procedure" to determine its condition.

Dakota Dilemma

My recently purchased 1987 Dodge Dakota pickup is giving me a fit when I try to shift the transmission into First or Reverse. The Dodge dealer insists that stiff shifting is normal for this truck. Is he leveling with me?

MARGARE GOITIA-CRUZ
LENNOX, SD

He was at the time you wrote to me. The solution to this problem is so new that as I write this only the Chrysler Motors technical service department has more information than I do.

Hard shifting is not normal. That's why the Chrysler technical service staff has modified the clutch. This modification involves replacing the clutch disc with a new disc (part No. 4338352), replacing the pushrod with an adjustable pushrod, and readjusting the clutch following the procedure outlined in a TSB. Sorry, I don't have the part number for the new pushrod or the TSB number. They weren't assigned as I wrote this, but both should now be in the hands of the dealer.

Bird Feeding

My 1985 Thunderbird doesn't like to be fed. In filling the gas tank at a normal feed-in rate, the Bird causes the pump mechanism to shut off 2 to 3 gallons short of full. I can ease in the missing gallons to get the tank full, but it takes forever. The pump mechanism keeps clicking off. I know air is trapped in this tank, but I don't know how to get it out. Can you tell me?

DARRELL LUCKEY
SAVANNAH, GA

I wouldn't even if I could. This is the way Ford fuel tanks are designed to work. The air space within the tank is there to allow for fuel expansion. If that air space weren't there, gas would be pouring on the road as heat caused it to expand in the tank.

The correct way to fill your T-Bird's tank is to dispense gas until the pump nozzle clicks off. Count off 5 seconds. Then, slowly feed in more gas at about half the normal fill-rate until the nozzle again shuts off. Wait another 5 seconds, feed it once more and that's it. **PM**

DO YOU HAVE A CAR PROBLEM?

Just ask Mort about it. Send your question to the Car Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

SERVICE TIPS

■ Squeaky brakes from a 1985½ or 1986 Toyota MR2 can be a thing of the past if you have newly designed front brake pads installed (part No. 04491-17070). They're made of a material different from the old pads, which are still safe to use even though they like to sound off.

■ Speaking of brakes, Chevrolet advises that if you've encountered a problem of rear wheel lockup after having your 1985-87 Celebrity parked in snowy weather, the rear brake drum cavities may have been snow-impacted. Under freezing temperature, snow becomes so rock-hard that it could prevent wheel rotation. New rear brake backing plates (part No. 18014157) keeps snow out of the cavity.

■ The lineup for this tip involves these Chrysler Corp. models: 1987-88 Daytona, LeBaron, Voyager, Ram Van and Caravan, and 1988 Lancer, LeBaron GTS, Sundance and Shadow—all with a 5-speed manual transmission that doesn't go into reverse without a struggle. TSB 21-13-87 says your vehicle's a candidate for parts contained in a new pullup ring service kit (part No. 4443404).

■ So you've been told that the wind noise in your 1987-88 Ford Crown Victoria or Mercury Grand Marquis is "normal." Tell you what you ought to do. Inform the one who told you this about TSB 87-19-3, which advises that weatherstripping at A-pillar door glass positions should be realigned. One or both could have been installed wrong to begin with.

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Division of Chrysler Motors

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OUTDOORS

BY JOE SKORUPA

King Of The Wild Country

I WAS IN grizzly country four times last year and the closest encounter I had was with a small, furry image receding in my binoculars. Still I felt the presence of *Ursus arctos horribilis* with every step I took. You have to respect the territorial instincts of a 300-to-800-pound, immensely powerful animal. Especially one that hates surprises.

Yet, statistically, I had little to fear. A face-to-face encounter with a grizzly is an extremely rare occurrence. Their acute senses swiftly detect humans and they usually move away long before they're seen.

But in extreme circumstances, when there is contact, the outcome can be fatal—frequently for the bear.

Since 1900 there've been 17 human deaths attributable to grizzlies in the lower 48 states, according to Chris Servheen, Grizzly Bear Recovery Coordinator for the U.S. Fish & Wildlife Service. During the same period, an estimated population of 100,000 grizzlies has dwindled to less than 1000.

Because of the sharp decline, grizzlies were declared a threatened species in 1975, and they are now protected by the Federal Endangered Species Act.

But the fight to find a place for the grizzly in the modern world is far from over. Although there are current grizzly populations in Montana, Wyoming, Washington and Idaho, residents of those states don't feel blessed by their good fortune. One Montana rancher was recently quoted as saying he advocates the "3-S method of grizzly bear management—shoot, shovel and shut up."

His sentiment is easy to understand. A grizzly is a volatile neighbor, who doesn't recognize national park or national forest boundaries. He's a wide-



Grizzlies are good-news/bad-news bears. Outdoorsmen stand to gain by their recovery, but others stand to lose.

ranging omnivore with a lethal mean streak.

Charles Gibbs was in Glacier National Park last spring when he spotted a grizzly mother with three cubs. He couldn't resist approaching them for close-up photographs. His 40 photos indicate he got within 50 yards of the grizzlies and followed them when they tried

to move away from him.

Eventually, he was perceived as a threat by the mother. She attacked. Gibbs tried in vain to climb a tree. His body was found 145 ft. from his camera.

Most people I talked to who know the details believe Gibbs probably bore some of the responsibility for the attack. Few mistakes in life re-

sult in death, but closing in on a retreating grizzly with cubs can be one of them.

Still, Gibbs' death is a tragedy and underscores the dilemma facing those responsible for grizzly management. How do you preserve grizzlies and protect people at the same time?

In 1979, a hunter shot an old female grizzly in Colorado's San Juan Mountains. It was the first verified record of a Colorado grizzly since 1952. The incident prompted a search for evidence of other grizzly bears, but after two years none were found. It seems likely the old female spent her final years wandering the mountains alone, the last of her kind south of the Montana/Wyoming border.

Unless the recently approved U.S. Fish & Wildlife Grizzly Bear Recovery Plan is successful, the story of Colorado's grizzly population may be repeated in other states. The plan, like everything to do with grizzlies, is controversial. It requires sacrifices. Hikers, hunters, fishermen, campers, ranchers, farmers and local businessmen all have to give up something. Campgrounds, trails and some federal grazing land need to be closed. Feed lots and dumps on private land have to be cleaned up.

But, if the lower-48 plan is successful, there will be benefits. Hunting, which already exists in Montana on a limited basis, could be expanded. Sections of wildlife-rich land bordering national parks and forests, now threatened by encroaching development, could be preserved. And, finally, the king of America's beasts, the magnificent grizzly, will not be wiped out in our lifetime.

Uneasy is the head that wears the crown and like other modern monarchs, the grizzly bear and his fate is now in our hands.

(Please turn to page 35)

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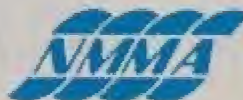


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OUTDOORS

(Continued from page 32)

Next-Wave Electronics

In the past five years we've witnessed an explosion in marine electronics. High-resolution imaging, interference



Integrator AV combines several pieces of electronic gear in a single instrument.

dampening, increased power, expanded functions and other space-age advances have surged through the waterways like a tidal wave.

Miniaturization and affordability have recently made dramatic gains, but even more interesting is the trend toward integration—combining features of several pieces of fishing and navigational gear into one instrument.

One of the first to ride this wave is Coastal Navigator, of Seattle, Washington. The company recently introduced its Integrator Series of sports fishing/navigation instruments, which combine the features of a fish finder, digital depth sounder, loran, trip computer, sonar, and wind, water and speed gauges.

The Integrator AV, affordably priced at \$995, is a prime example of the series. It has a high-definition CRT with 16 shades of amber for signal discrimination. Plug-in optional enhancements include a Loran box and scanning sonar head. Multiple modes of operation can be viewed with a split screen.

Integration of every piece of electronic gear and gauge into a single command-station instrument is, perhaps, just around the corner.

Stowaway Power

It's not too early to start thinking about spring boating and RV outings, and preparing for prime recreational time that



Deep-cycle, crank-up power for RV and marine applications.

lies ahead. Choice of a deep-cycle battery, though not on the top of our mental list, is a major component of a successful recreational season, because everything, from trolling motors to depth finders to radios, TVs and water systems, depends on it.

Two new batteries, by GBN, Inc., of St. Paul, Minnesota, are of special interest due to their exceptional deep-cycle output and cranking power. The batteries are part of the Stowaway line, and each has more than enough power to start most marine drive systems or power-hungry generators.

The ST-124 is a smaller, lighter ver-

sion of the monster ST-154, which offers 600 cold-cranking amps and nearly 17,000 amp hours. One of the ST-154's drawbacks is its weight—59 pounds. The new ST-124 weighs in at a lighter 47 pounds, while still offering a hefty 500 cold-cranking amps. For even lighter, less power-demanding duty, the new ST-64 offers 360 cold-cranking amps in a 29-pound package.

All three models in the Stowaway line feature a pressure valve that vents fumes and stainless-steel terminals that are corrosion resistant. Also, they're 100-percent sealed and constructed to take a pounding.

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AVIATION

BY FRED MACKERODT

Good Guys/Bad Guys

WITH 1988 in full swing, I'd like to get a few plaudits/peeves about general aviation down on paper.

Good Guy of the Year: Stuart Millar, the new owner of Piper Aircraft, who, after buying that company, quickly resumed the production of light aircraft and also immediately lowered the price of parts 40 percent and Piper airplanes 20 percent. Mr. Millar is also evidencing the courage to fight the fast-buck artists who would drive the general aviation industry into the ground with liability litigation.

Millar's latest upbeat move was to announce that Piper will be producing a turbine-powered version of its pressurized Malibu 6-seater. The powerplant is a Pratt & Whitney PT6A-11 flat rated to 400 shp. Max cruise is targeted for more than 240 kt. at 25,000 ft. and initial rate of climb through 15,000 ft. will exceed 1500 fpm.

Another Good Guy: Vice Admiral Donald Engen, who, during his 36-year career as a naval aviator, never once got either seasick or airsick. He's sorry he can't say the same thing about his three years as FAA administrator. Engen, a pilot with 8000 hours in 240 different aircraft and an FAA administrator for three years, is now running the Air Safety Foundation of the Aircraft Owners and Pilots Assn., using his considerable talents to make the skies safer.

More Good Guys: The controllers and tower people at the Allentown-Bethlehem-Easton Airport in Pennsylvania, who are unfailingly courteous and patient with all—including yours truly—when they come to practice instrument approaches.

Bad Guys: RAS Maintenance Services, a division of USAir, also at Allentown Airport, which charged me



A longer snout and added muscle: Piper's turbine Malibu.

13.5 hours at \$38 per hour to replace a mechanical fuel pump on Aztec N87A when the job should have been done in 3 hours. The only thing more surprising than the size of the bill was losing the pump—and the left engine—on takeoff, which prompted the visit to their shop in the first place.

Bad Guys: All the undesirables, including some rather large corporations, who think aircraft owners are made for the fleecing. We include in this the bloodsucker at the Experimental Aircraft Assn. Convention in Oshkosh, Wisconsin, who offered to "exchange" a bad autopilot attitude indicator for a quick \$1700. We discovered the instrument was bad over Lake Michigan on our way to Oshkosh from New York, when the Aztec made like a space shuttle, pitching up as if headed for the Moon. Just when you think you have everything under control, things like this happen to get your attention.

Good Guy: Don Lynch of Century Instruments, Wichita, Kansas, who provided the writer a loaner attitude indicator to get home from Oshkosh with not so much as a handshake as security—and then repaired the bad one for \$195.

A Bunch of Good Guys: Frank Christensen, Herb Andersen and all the people of Wyoming-based Christen Industries, Inc., who are hard at work building the Christen Husky (see photo). The Husky is an improved

version of Piper's now-defunct Super Cub. Although some flying enthusiasts are expected to plunk down the \$55,500 price of the Husky just for the fun of it, most of the airplanes will go right to work when they leave the Afton, Wyoming, factory. The U.S. border patrol has 12 on order, and a lot of ranchers and animal-predator-control types are buying the airplanes. Like its predecessor, this tough little airplane lands in as little as 300 ft. and take off in 150 ft. It also flies all day as slow as 45 mph indicated. But unlike the 150-hp Super Cub, which cruises at 110 mph, the 180-hp Lycoming-engined Husky boogies along at 140 mph using 75-percent power.

For more information on the Husky, write Christen Industries, Inc., P.O. Box 547, Afton, Wyoming 83110. (307) 886-3151.

Lop-sided Guys: The experts whose solution to airport overcrowding is to throw out the three general aviation aircraft that land a day to make more room for the 500 airline flights.

Our Own Personal Good

Guy: Tom Gillespie, manager of FlightSafety Academy in Vero Beach, Florida. Tom is a former General Motors' test pilot (when that corporation was manufacturing planes), a Marine fighter and torpedo bomber jockey, a member of the development team of the original King Air and senior vice president of Piper Aircraft. Tom now spends his time turning out future pilots. Unlike most people in the business who feel that young pilots must have at least 1500 hours flight time under their belts before they plop their butts into the right seat of a jet, Gillespie believes that top pilots can be turned loose in as little as 225 hours if they are trained properly. In fact, FlightSafety is doing just that for Swissair, among others, at their Florida facility. FlightSafety Academy is at (305) 567-5178.

Model Guy: We heard about Bob Morrison through aerobatic ace and friend Leo Loudenslager. Bob is a retired aeronautical engineer who began collecting drawings and photographs of airplanes when he was 14 years old. That was 60 years ago and Bob now has the largest "scale documentation" collection in the world. If it flies or floats, or ever flew or floated, Bob has material on it. The airplane catalog is \$2.50 and the ship catalog is \$2.75. Repla-Tech International, 48500 McKenzie Highway, Vida, Oregon 97488. **PM**



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INSIDE DETROIT

BY JIM DUNNE

The Legacy Of GM-80

THIS SLEEK 4-seat sports car was once the prototype for the 1991 Pontiac Firebird. It was to be a dramatic departure from the design of today's Firebird with plastic body panels, front-wheel drive and a V6 engine. A similar car with different styling was planned for the Camaro as well. But GM's braintrust overreached itself on this car, and so, about this time last year, the project was dropped. Insiders at GM claim that the change to the completely new design would cost too much money—probably close to \$1 billion—and the investment would not give GM clear superiority over Ford's highly popular Mustang.

Instead, Firebird and Camaro will remain front-engine, rear-drive types, with a powerful V8 engine still the prime powerplant. But that was not the end of the story as far as the GM-80 project was concerned. "We learned a lot of things about front-wheel drive and handling (in the GM-80 program)," a Chevy engineer told me. "We will be sure to use that in other cars we're working on." Recently, GM-80 prototypes like this one shown on the flatbed truck, have been returned to testing schedules. It's a good bet that some of the lessons learned in the GM-80 will be turned into designs for future Cavaliers, Sunbirds and other front-drive models. However, if you like the styling of this prototype, you may like the rear-drive Firebird as well. Word is that many elements



GM-80 project car has been dropped, but technology developed in the program is finding its way into other GM vehicles.



of the GM-80 shape will find their way into the 1991 Firebird and Camaro.

Another Corsica

Chevy will round out its Corsica line next fall with this 5-door hatchback sedan. The body design will give the car more flexibility and permit the owner to use the sedan like a station wagon. The rear seats will fold down so that longer loads can be carried between the trunk and the rear seat space. Styling at the rear window follows the theme of the Beretta and Camaro, with a compound curve in the glass. This curve shape will be seen on many future Chevrolets, including the completely redesigned 1991 Caprice.

Cadillac Allante

Minor changes will be made in the Allante for 1989 as Cadillac tries to fine tune its flagship coupe to make it more attractive to

the car buyer who can part with \$56,000. Most obvious is a more sporty appearance in the road wheels. Spoked wheels replace the alloy dish design to present a more sporty appearance on the outside. Inside, a bigger engine of 4.5-liter displacement that develops nearly 200 horsepower (up from 170 this year) will furnish Allante with the performance it needs to compete with other luxury coupes.

Meanwhile, unsold Allantes pile up at dealerships as production outpaces sales by a margin of 2 to 1.

Four-Wheel-Drive Sportster

Jeep Eagle division of Chrysler will have a 4-wheel-drive sporty car in its lineup within two years, if present plans work out. Jeep Eagle is the outfit that was American Motors before Chrysler purchased the compa-

ny last summer. Since the takeover, Chrysler and Eagle officials have been busy figuring out which sedan vehicles are best suited for the Jeep Eagle division. Already set are the Premier and Medallion. Almost set is a plan to offer a 4-wheel-drive version of the car built by Diamond Star in Illinois. Diamond Star is an assembly company jointly owned by Chrysler and Mitsubishi. It plans to get into production later this year with a 2+2 fastback sporty car that will be similar to the Nissan 200SX in size and price. One version of this car will go to Dodge and Plymouth dealers. Another, including a 4-wheel-drive model, is being planned for Jeep Eagle. Company executives believe that Jeep Eagle should have a unique lineup of cars, one that concentrates on European sedans like Premier and Medallion along with 4-wheel-drive models in sport types as well as in regular Jeep utility vehicles.

T-Bird Drops V8

Ford plans to drop the V8 engine from the 1989 Thunderbird, and in its place will offer the 3.8-liter V6. A supercharged version of the 3.8 V6 will also be offered in the Thunderbird Super Coupe. The supercharged V6 takes the place of the turbocharged 2.3-liter 4-cylinder engine, just as the Super Coupe replaces the Turbo Coupe in the T-Bird lineup.

Sources say the supercharged V6 will develop horsepower in the 225 range,

(Please turn to page 40)



'89 Corsica: Compound-curve rear glass for station-wagon utility.



'89 Allante: Sportier wheels and more oomph from engine.

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INSIDE DETROIT

(Continued from page 48)

and since the supercharger delivers boost at all engine speeds, there is no lag in power delivery, a common complaint with turbos.

As a result, the supercharged V6 should accelerate the new T-Bird to 60 mph in less than 8 seconds.

In 1990, Ford will return the 5-liter V8 to the T-Bird line because "there is still a great demand for them." Engine plans for the 1989 and 1990 Mercury Cougar are similar to those for Ford's Thunderbird.

Dodge To Get Jeep

Dodge dealers will sell Jeeps in the future, but not before the restyled ZJ Jeep goes into production in 1990. Until then, Jeeps will only be sold through Jeep Eagle dealers. The plan is all part of the rearrangement going on in Chrysler that is necessary to merge American Motors models with Chrysler types.

"For \$20,000 less" Chrysler sees no problem selling 3000 to 6000 of its \$35,000 Maserati convertibles each year, despite the problems Cadillac is having in moving the Allante. "Ours carries a prestige name—Maserati—and sells for \$20,000 less (than Al-

lante)," boasts Chrysler Executive VP Bob Lutz. As for its late introduction, Lutz explains, "It's our flagship so we want it to be dead right. We're taking extra time fine-tuning the trim inside and outside."

Chrysler's V6

Next year at this time Chrysler hopes to be in production with its own V6 engine for the company's prestige sedan lines, including a new Imperial as well as the New Yorker Landau and Dodge Dynasty. Insiders confirm that the new powerplant will be 3.3 liters in displacement, and designed to replace the 3.0-liter V6 that Chrysler now buys from Mitsubishi. Look for this engine to be used in applications where the 3.0-liter Mitsubishi is the performance option.

BMW's 750iL

"We built it to ride like a heavy car, but in turns it seems to lose a ton of weight." That's the way BMW executives explain the ride and handling of the super-luxurious 750iL sedan, the new 4-door equipped with a V12 engine. The claim is true. We found that the 750iL does have small-car nimbleness in turns, but still produces the limousine ride in straight-ahead driving.

All this is done without the tricks of electronic suspensions. "We designed the 750iL suspension before the electronic shock absorbers were truly perfected," a BMW engineer explains. "But that does not mean we will not use electronics in the future."

BMW is not afraid of electronic controls. It is the first company to install a totally electronic accelerator in its automobile. The \$67,000 750iL has no mechanical connection between the accelerator pedal and the engine. It's all done by electric signals.

Make Up Your Mind

GM is still revising its Saturn project even though the first cars are due off the assembly line two years from now. The car that GM unveiled two years ago when Saturn was first announced is no longer in the plans.

The original scheme was for a sub-compact 4-seater, powered by an all-aluminum, 4-cylinder engine that would compete with the most popular imports in price, quality and innovation. The project's total cost: \$500 million.

Now, that expenditure has been cut in half and the original styling scrapped in favor of a more aero shape on a bigger chassis. The aluminum engine is still talked about, but you can be sure that the engine will be shared with other GM cars, not reserved exclusively for Saturn. Also, there may be plans to fold Saturn cars into the normal GM distribution system, selling them through Buick or Olds dealers.

PM



Radar detectors: Which are really best?

These days every maker says their radar detector is best. Who's telling the truth?

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Car and Driver April 1987	Roundel June 1987	Popular Mechanics July 1987
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Cobra	BEL Quantum	Passport
Uniden	Whistler	BEL
Radio Shack	Maxon	Snooper
BEL	Radio Shack	Uniden
Whistler	Uniden	Whistler
Sparkomatic	Fox	Cobra
Fox	Cobra	GUL
GUL	BEL Vector	Radio Shack
	Snooper	Sparkomatic
	Fuzzbuster	Maxon
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OLD HOUSE RESTORATION

BY BOB VILA

Wood-Stripping Decisions

YOU'VE just bought the old house of your dreams and shudder at the condition of its trim-work. Layers of paint hide any ornateness and you dream of restoring the woodwork to its original unpainted elegance.

There's no one "right" way to remove paint from wood trim. But a brief explanation and evaluation of the alternatives available will help you to make an intelligent decision. Which method you choose will depend on the time you've allotted for this job, how much money you're willing to use from your restoration budget, and your own preferences for one method over another.

Stripping woodwork is an expensive proposition, whether you do it yourself or hire someone to do the job for you.

Doing the wood stripping yourself will cost a lot of time, hiring someone can cost a lot of money.



One of the best ways to remove layers of old paint is with a heat gun and putty knife.

In-place removal

As far as I'm concerned, there are three ways to remove paint from interior wood trim: mechanically, chemically and using a heat gun combined with a putty knife. Like anything else,

each process has its good points and bad.

Mechanically removing paint with a scraper is hard work and you risk gouging the wood. Of the do-it-yourself methods, it's probably the hardest. The more ornate

the molding, the more difficult this type of removal is.

Stripping paint this way is costly in terms of time. It's messy, dusty work and, when old lead-based paint is involved, this dust becomes more than just a nuisance. It creates a serious health hazard when it is breathed or ingested.

Removing paint with chemical strippers is also a messy and time-consuming job. You'll usually still have to scrape a little to get the last bits of paint out, so you still risk scratching and gouging the wood. I've also noticed that many times chemical strippers raise the wood grain. But it's usually nothing that a good sanding can't correct. The biggest drawback to this process is the potential health hazard that results from inhaling some of these fumes. (I'll discuss this in more detail later.)

Using a heat gun coupled
(Please turn to page 46)



A hand scraper removes paint well but can scratch and gouge wood.



Chemical strippers are easy to use but can be very costly for big jobs.

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Drive-in



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'59 CADILLAC



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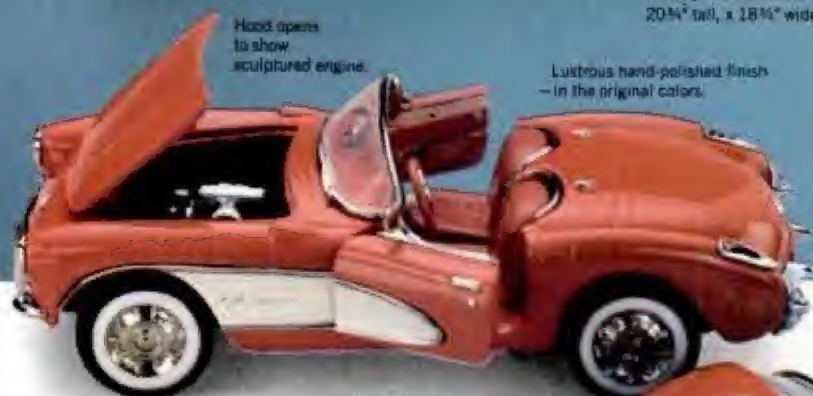
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The Classic Cars of the Fifties

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OLD HOUSE RESTORATION

(Continued from page 41)

with a putty knife and scraper to loosen and remove paint is the third alternative. It's usually the one I like best. Many times, a thick layer of paint will come off quicker this way than when it's removed chemically. Of course, you've still got to be careful you don't nick the wood. It's usually quicker than using a scraper alone, and eliminates the fumes that go along with chemical work.

Woodwork to go

There are a couple of other alternatives available for restoring wood trim. In many cases, you can remove the moldings and send them out to be dip stripped. But, this isn't as easy as it sounds. True, you'll save lots of time on the actual stripping labor, but getting the moldings off and back on again is quite a job!

Each piece of wood must be carefully pried off the wall and labeled. (Remember, you'll have to put the puzzle back together again!) Then, the nails have to be removed. But, don't be tempted to drive the nails through the front of the molding. This is a common mistake, and the putty that covers the nailhead, coupled with the layers and layers of old paint, is likely to pull chunks of precious wood out with it. Always pull the nails through the backside, using either locking pliers or a nail puller.

The moisture the old wood is exposed to during dip stripping may cause it to swell a bit. Make sure it has had time to dry out completely before the pieces are reinstalled. Once on the wall, you'll have to putty all the holes and sand the boards smooth again. So you can see that this process, too, is fairly costly in terms of time.

If the woodwork is in bad shape, pieces are missing throughout the house, or perhaps a previous owner replaced some of the old stuff with modern trim, it might be worth your while to have new woodwork milled to replicate and replace the old.

Since the machine setup costs are usually the biggest expense on a job like this, it doesn't pay to have millwork done to replace only 10 or 20 ft. of moldings. The more you have done, the more efficient this method becomes.

It's probably the best alternative if you've got to repair or replace the woodwork in all or most of the house. I know of one recent project where it was more cost-effective to replicate all the trimwork in a house as compared to removing all the buildup paint.

Do it safely

No matter what method you choose to strip paint from wood trim, always keep the safety of yourself and your family in

mind. Two of the main concerns here are with the lead-based paints and the stripper fumes.

Always wear a respirator that fits right and is designed for the particular hazards you may face, whether it's lead dust, particles, vapors or solvents. Many times professional advice is needed to ensure that you've got the right protection.

A local safety-supply house is a good place to start. Or you can always call your nearest Occupational Safety and Health Administration (OSHA) office. Explain what you plan to do, whether it involves chipping, heat or solvent use. An OSHA professional should be able to advise you on the purchase of a respirator that's approved for that particular usage. Always wear the proper eye and hand protection, too.

Anytime you're working with lead paint (to be on the safe side, assume you are removing lead paint if your house was built before 1950), seal the room off from the rest of the house to prevent the dust from traveling. Work in a well-ventilated area, and wear disposable coveralls or, at the very least, launder your work clothes separately. Don't eat, chew gum, smoke or put your hands in your mouth. Don't attempt any lead-paint removal if there are children or pregnant women in the house.

Proper cleanup when lead paint is involved is crucial. Don't vacuum, since many filters aren't fine enough to prevent spreading the lead dust. Wet sweeping usually works best to get the shavings and chips off the floor. If you're renovating a single-family home yourself, it's usually okay to place the lead-paint residue in tightly sealed plastic bags and discard it along with the rest of your household trash. To be on the safe side, however, it's best to contact your state's Department of Health or Environmental Protection Agency for any specific regulations.

Finally, a word about the safe use of chemical strippers. The U.S. Consumer Product Safety Commission (CPSC) now requires labels warning of possible cancer hazards on all strippers that contain methylene chloride. (This chemical has been shown to cause cancer in animals during laboratory testing).

To protect yourself against possible exposure, the CPSC suggests outdoor use of products that contain this ingredient. If you must work inside, do so only under high-ventilation conditions where there is a positive flow of air. Opening doors and windows is not enough: The CPSC advises using a fan to exhaust the air outside. Or, use an air-supplied respirator.

No matter which method you choose, be prepared for hard work. But the end result of gleaming, polished wood will be well worth it.

PM

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Machines: The Soul Of Science

REDUCED to essentials, science is a process of deduction based on observation. While ancient scientists relied on their eyeballs and a quaint system of myth and logic to arrive at their conclusions about the cosmos, later generations were able to refine their ideas based on an improved capacity to see. Instruments made the difference.

Robert Hooke's invention of the twin-lens compound microscope, based on an instrument created by Anton van Leeuwenhoek, led to the discovery of the cell. For 50 years, giant electron microscopes have allowed scientists to observe not only Hooke's cell but the cell's individual atoms. Galileo Galilei's invention of the telescope confirmed Nicolaus Copernicus's theories of a heliocentric solar system, with the Earth and its sister planets revolving around a life-giving Sun. Astronomers today have built upon Galileo's simple tubes and lenses to create huge reflecting telescopes that gather light from the far reaches of space. Larger radio telescopes, reflector arrays and the orbiting telescopes of the future will permit astronomers to see to the edge of time.

Machines like these and others allow scientists to see farther and peer deeper, to roam the frontiers of the unknown, develop ideas, confirm the theoretical and generally build the base of knowledge that allows the great swaying thunder of science to proceed unabated.

What are the latest devices that help scientists see and do? What are the contemporary equivalents to the microscope and telescope.

Consider the machine recently developed by Cornell



Cornell's Jack Freed and Jeff Gorcester with their electron spin resonance device.

chemistry professor Jack Freed, aided by graduate assistant Jeff Gorcester. With the mouth-filling tag "2D Fourier Transform Electron Spin Resonance Spectroscopy," shortened to 2D-FT-ESR, scientists can now observe not only the molecules of a compound, but they can "see" chemical interactions that occur in billionths of a second.

How does it work? Electron spin resonance is based on the fact that spinning electrons are, in effect, tiny magnets. Another important analytical tool, nuclear magnetic resonance spectroscopy, or NMR, is based on similar phenomenon—the spinning of atomic nuclei.

With NMR, powerful magnets are used to align these atomic nuclei like the needles of countless compasses. Bursts of radio waves are then beamed at a sample, which causes the nuclei to point in different directions. When they realign themselves, they emit some of this absorbed energy as radio signals. How these radio signals change with variations in the controlling magnetic field gives scientists insight into the molecular structure.

The process is similar with ESR spectroscopy, but electrons have a magnetic field a thousand times greater than atomic nuclei, which allows electrons to absorb and re-emit energy much faster, a

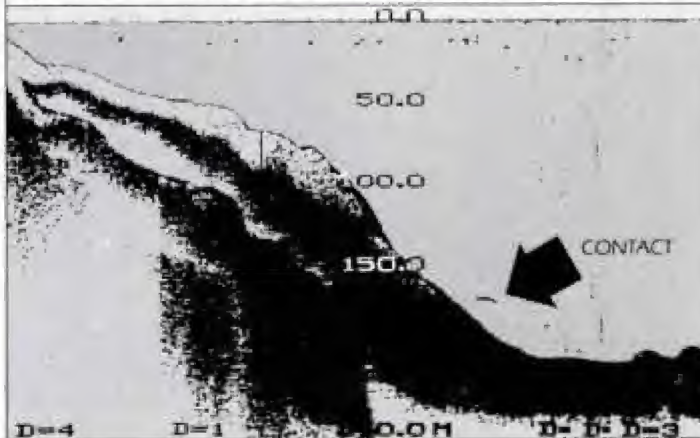
process that allows scientists to observe ultra-fast molecular reactions.

Freed and Gorcester have improved on existing ESR techniques by developing electronics that produce and detect precise, high-powered microwave pulses lasting 5 to 10 nanoseconds long. Previous ESR machines used "continuous wave" microwaves that gave a less clear picture of molecular interactions. The device will give scientists deeper insight into the mysteries of inner space.

This remarkable machine will also open up wide avenues of intellectual inquiry—and begs a perennial question: What kind of science will we be able to achieve in the next generation using such fabulous machines? Not even Leeuwenhoek would have the answer to that one.

Nessie: A Myth Intact

Despite the foregoing salute to modern scientific machinery, it just wouldn't do to have gadgetry come along that calmly punctures our myths. The Loch Ness monster is a case in point. Despite the best efforts of scientists aboard a flotilla of boats performing a sonar sweep of the loch this past summer, the monster managed to elude concrete detection. Or did it? PM correspondent Bud McDonald, on hand for the huge exercise sponsored by sonar-maker Lowrance Electronics, reports that promoters of "Operation Deepscan" spotted a large moving object 170 meters deep 400 yards off shore. Could it have been a descendent of the landlocked plesiosaur first spotted in 565 A.D.? Fortunately, the machine hasn't been invented that will let us know for sure.



An ill-defined streak produced on a Lowrance X-16 chart recorder. Is it the Loch Ness monster?

AUDIO

BY FRANK VIZARD

Golden Age Of Wireless

IF THERE is any problem with loudspeakers it has to be the wiring. And if you want to create a real headache for yourself, try wiring a second pair of speakers for a surround sound system, or for another room. Even wiring one pair of speakers to a receiver can be troublesome if the electronic components are on the opposite side of the room.

A solution to wiring problems comes from two companies, each offering its own version of a wireless speaker. Although Koss and Recoton have developed similar products, the technology each uses is very different.

The Koss approach utilizes infrared technology. Infrared audio transmissions have been researched for years, but it was not until the recent development of a compander chip—it reduces the noise caused by the infrared optics—that true high-fidelity audio transmissions became feasible.

In a methodology similar to the existing Koss wireless headphone, an infrared wireless transmitter is plugged into a source unit's headphone jack. The transmitter converts the audio signal into an infrared beam that is dispersed throughout the room. The transmitter beams two discrete analog FM-carrier frequencies, 95kHz for the left channel and 250kHz for the right. Each speaker has a photo diode sensor mounted on its top. This sensor captures the infrared beam and converts it back into an audio signal. The sensor in each speaker is able to pick out the appropriate left or right frequency.

Each speaker has its own volume and tone control as well as an ON/OFF/CHARGE switch. Each can be plugged



Koss Kordless speakers (above) receive sound via infrared light. Recoton Wireless 100 (left) uses AC wiring.

into an AC outlet for power, or run on eight "D" cell batteries or rechargeable NiCd batteries.

Koss rates its JCK/5000 wireless speakers as having a frequency response of 40 to 20,000 Hz with less than 1.5-percent distortion. Each speaker has two drivers, a 6½-in. woofer and a 2-in. tweeter.

I must admit to being pleasantly surprised by how well the JCK/5000 speakers performed. Having used Koss and other cordless headphones, I expected to hear a lot of "hash" when the infrared beam was blocked or interrupted. Koss, however, has employed a bit of circuitry not present in its cordless headphones because of space considerations. This circuitry is designed to put the amplifier in each speaker in a standby mode when its reception of the infrared signal is interrupted. The circuitry has the practical effect of muting the speaker until the full infrared signal is re-

ceived, thereby eliminating any unwanted noise that could result from a weak or missing infrared signal. The muting only becomes noticeable if the infrared signal has been blocked for a substantial amount of time.

I found the JCK/5000 speakers performed best when the transmitter is placed 5 ft. or more above the floor. A high location for the transmitter seems to help distribute the infrared signal around the room more effectively. People casually walking between the speaker and transmitter had no adverse effect on the audio in terms of interrupting the signal.

The sound quality of the JCK/5000 is good—but not so great that I would recommend it as a primary speaker system for a serious music lover. The relatively small size of the speakers—they're designed for wall hanging—as well as the practical limitations imposed by the size of the power supply combine to limit the amplifier's out-

put, the size of the drivers and, therefore, the sound pressure levels the speakers can generate. List price for the JCK/5000 is \$350.

In contrast, the Recoton wireless speakers cost \$100 less and actually have more flexibility. The Koss speakers are confined to the room where the transmitter is located. The Recoton speakers can be placed anywhere in the house.

Like the Koss speakers, Recoton also utilizes a small transmitter plugged into the headphone jack of a source unit. The transmitter sends each channel of the stereo signal on a discrete carrier via the AC wiring in your house. Once you've plugged in the Recoton "Wireless 100" speakers into the wall, two receivers housed in the "active" or left speaker pick out the audio signal for reproduction. A patchcord relays the right channel information to the "slave" or right speaker.

The active speaker also contains a proprietary circuit that rejects any unwanted electrical noise or anything besides the desired audio signals. You won't help the proprietary circuit by plugging the speakers into a surge-suppressor outlet strip. The surge suppressor will filter out the desired audio signal altogether. The active speaker also has the built-in amps, and ON/OFF and VOLUME controls.

The Wireless 100 speakers are designed to be used as a utility product—something to be plugged in when you want music in another room or out on the patio. The cabinets house drivers that are only 4½ in. in diameter and their frequency response is limited from 60 to 15,000 Hz—which means that you shouldn't expect to hear everything that might be on a CD. In fact, with compact discs as a source, the 100s

tend to put a lot of the snap, crackle and pop associated with vinyl records back into the music, particularly if you don't accurately match the volume levels between your receiver and the active speaker.

Their intended role as a utility product also restricts amplifier power to 10 watts per channel.

Nevertheless, other audio specifications are quite promising, particularly the separation figure of 60 dB. It's definitely a figure you can hear in the playing. In theory, the use of two separate signal carriers actually makes the potential separation "infinite."

Small portable speakers that just plug into a wall to deliver music on demand have their uses. And they would also work well as the second, rear channel pair of speakers in a surround sound system.

Still, I'd like to see Recoton's wireless technology adapted to larger speakers with better specifications. I have to give the Koss speakers an edge in sound quality at present, but the technology used in the Recoton speakers has the greater and more versatile long-term future.

DAT: Ford's First!

Ford has become the first automaker to publicly embrace the digital audio tape (DAT) format, a medium comparable in sound quality to compact discs (see "Digital Audio Cassettes: Small Tape, Big Sound," page 106, July '87). Ford says it will offer playback-only machines as an option in mid-year 1988 Lincoln Continentals.

The machine is being supplied by Sony and Ford officials estimate that the DAT option will cost between \$1200 and \$1500.

The DAT unit itself will not have a tuner so it will be coupled to a standard AM/FM cassette receiver, making dual tape formats available to the driver. The DAT machine is also meant to be sold in conjunction with the 140-watt Ford/JBL audio system that has long been available in Continentals.

Look for a hands-on review in this space in the near future.

In any event, the Ford announcement will open the door for other electronic companies to enter the market. The Japanese can point to Ford as the DAT leader, if Congress should say anything negative, and Congress is not likely to get mad at Ford.

Car DAT machines are play-only devices and this nicely sidesteps the copying concerns of the record industry. CBS Records' proposed copyguard on CDs should also fade away now that Sony has acquired the company.

Meanwhile, the play-only DAT devices should stimulate the demand for recorders and prerecorded software. **PM**



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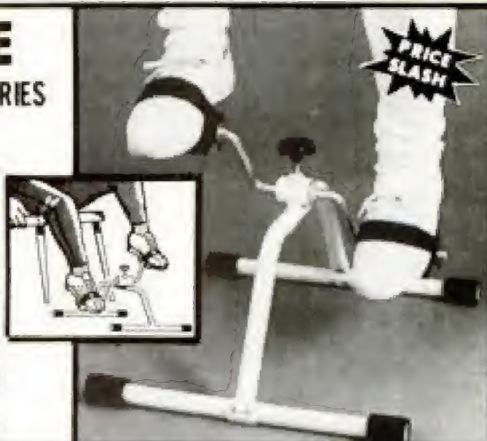
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PHOTOGRAPHY

BY STEPHEN A. BOOTH

'88 Debut For Filmless Photos



Konica's prototype filmless camera.

IT MAKES nearly seven years since Sony gave us a peek of the future with its experimental Mavica magnetic disc camera, but 1988 seems to be shaping up as the breakthrough year for filmless photography.

This is not to say that electronic-imaging or still video picture makers don't already exist. Canon began selling its Still Video System in the summer of '86 ("Photography," page 54, July '86) and since that time, major photo and electronics firms such as Chinon, Fuji, Hitachi, Kodak, Konica, Minolta, Nikon, Panasonic and Polaroid have shown they're ready to enter the club. News of these prototypes has appeared in this column at one time or another. Most recently, Sony finally put a price and delivery date on its ProMavica hardware.

Trouble is, all of the systems previewed or introduced to date are aimed for professional or institutional use, and therefore carry hefty price tags. How hefty? Figure a cool 15-grand for the mag-disc camera, a playback deck for the disc, and a color printer to churn out snapshot-size copies. The new Sony ProMavica camera would set you back \$4000 alone.

What's been missing is an electronic still camera that costs less than a Yugo and of-

fers playback directly to your TV set from the camera—in other words, a still video camera for amateurs. Until this year, that is.

Casio, an electronics company best known for musical instruments, calculators, wristwatches and typewriters, plans to introduce just such a filmless camera for about \$1500. The VS-101 isn't exactly cheap—you can shoot a lot of Polaroid Spectra instants for that dough. Nor does it do all the things a Sony ProMavica or Canon SVS will do (or do them as well). But Casio's filmless snapshooter is a first of its kind: If you remember how expensive the first VCRs

were, you'll see the VS-101's price tag in context. Because the VS-101 is expected to hit these shores soon, it might be worthwhile to review how electronic still photography works.

The camera itself might resemble a 35mm SLR, as Canon's SVS does, or it might take the shape of a medium-format roll film camera the way the Sony and Konica entries do. Kodak's prototype mag-disc camera looks and handles like binoculars. And Casio's VS-101 is reminiscent of a mini-video-camcorder. Whereas conventional cameras expose and store images on light-sensitive film, the still video camera first registers an image on the same type of solid-state pickup found in video movie cameras and camcorders, then stores the information as FM signals on a magnetic medium. Unlike video movie systems, which use magnetic tape cassettes, the still video cameras store their information on a small



Sony's filmless ProMavica costs \$4000.

magnetic disc whose hard-shell housing measures about 2 in. sq. Just like videotape, the disc can be erased and reused.

This disc spins at 1800 rpm, and the FM signals it receives are recorded in the standard NTSC video for-



Yours for \$1500, soon: Casio's filmless VS-101.

Tips For Better Pictures



Sandwiching Leftover Slides



EVERY roll of slides has some bad shots, but sandwiching the rejects can yield startling images. Hold two or three different scenes together against the light. When you find a combination you like, remove the transparencies from their individual mounts, clean away dust, and slip them together in a plastic slide mount. You can project the combo, or dupe it as a single slide. Shown here is an overexposed vertical of a skyscraper sandwiched with an overexposed horizontal of a sunset.

—Armand Ensanian



Radically styled Kyocera Samurai is a half-frame, autofocus SLR with 3X power zoom.

mat, just the same as that used for TVs and VCRs. The disc's image capacity does vary, according to the picture resolution desired. In the Field mode, the disc holds 50 images, each comprised of a single NTSC field. In the higher-resolution Frame mode, each image consists of two NTSC fields or one full TV frame. This means disc capacity is reduced to 25 images. Casio's VS-101 records only in the Field mode, whereas professional models offer both. Another difference is found in the lens and focusing areas. Some of the pro models focus automatically. Most offer interchangeable lenses, or at least variable focal-length zoom lenses. But the VS-101 comes with a permanent fixed-focus lens.

Where the VS-101 steals a march on the pros is in its playback ability. Most still video cameras are record-only machines. You have to switch the disc to a separate playback deck to display the pictures on TV, transmit them or print them. Uniquely, Casio's VS-101 permits playback right from the camera, for display on your home TV via simple, VCR-type connections.

What about prints? Casio says it will offer an optional, color snapshot printer at a later date, for about the same price as the VS-101. This, in fact, is the vision many parties have for filmless photography: a printer in every home. This might come to pass, when printers become as inexpensive as transistor radios. Meanwhile, other visionaries believe the job can be done less expensively, and with better results, by the same photo processors we bring our film to today.

Ninja Camera

No, the young woman wielding the camera here isn't using the latest still video magnetic imager. But she is wielding the hottest new film camera in Japan.

It's called the Samurai and it's the first in a line of "new concept" film cameras from Kyocera, the electronics company that is also the corporate parent of the Yashica photo brand. In Japan, the radically styled Samurai sells for about \$500. Kyocera has not yet decided whether to sell it abroad—perhaps be-

cause it's too radically different?

Though our model friend is holding the camera with two hands, it's designed to be palmed and operated with only one. The vertically oriented Samurai combines the simplicity of point-and-shoot, compact rangefinder cameras with the electronic sophistication and optical versatility of the new Maxxum school of autofocus SLRs. To wit: The camera's computer brain makes all the exposure decisions for you, while its computer eye focuses precisely. Loading, rewinding and film-speed selection are also performed automatically.

A powered zoom has a 3X ratio, 25-

75mm f/3.5 lens, the equivalent of a 35-105mm lens. Why equivalent? The answer is found in the camera's vertical shape. The Samurai, you see, is a half-frame 35mm camera: The film scrolls from bottom to top instead of sideways. This yields two 17 x 24mm horizontal frames in the same space of the conventional 24 x 36mm frame exposed by regular 35mm cameras. For this reason, Kyocera has yet to announce U.S. delivery. Half-frame cameras have never been popular in the States, especially among processing labs. Samurai's uniqueness might change all that. If so, watch for our hands-on test. **FM**

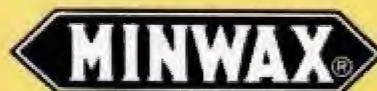


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CAR OF THE FUTURE

PART 3 OF A SERIES

**Popular
Mechanics**
MARCH 1988

POWER FOR TOMORROW

The engine in your future car may be a little weird. But it will be very familiar too.

BY NORMAN MAYERSOHN AND KEN ZINO

AS THE AUTOMOBILE speeds toward the 21st century, a revolution is in progress under the hood.

A car that's fun to drive has become a priority among car buyers. Good performance is expected when that pedal goes down. So, the industry is gearing up for a horsepower race unlike anything since the 1960s—with one major difference.

In the quarter-a-gallon '60s, more horsepower was a simple matter of more displacement. But in a fuel economy-conscious environment that places increasing emphasis on volumetric efficiency—more power from a given displacement—the game has changed considerably. Consequently, the engine you light up one fine morning in 2001 may share internal combustion



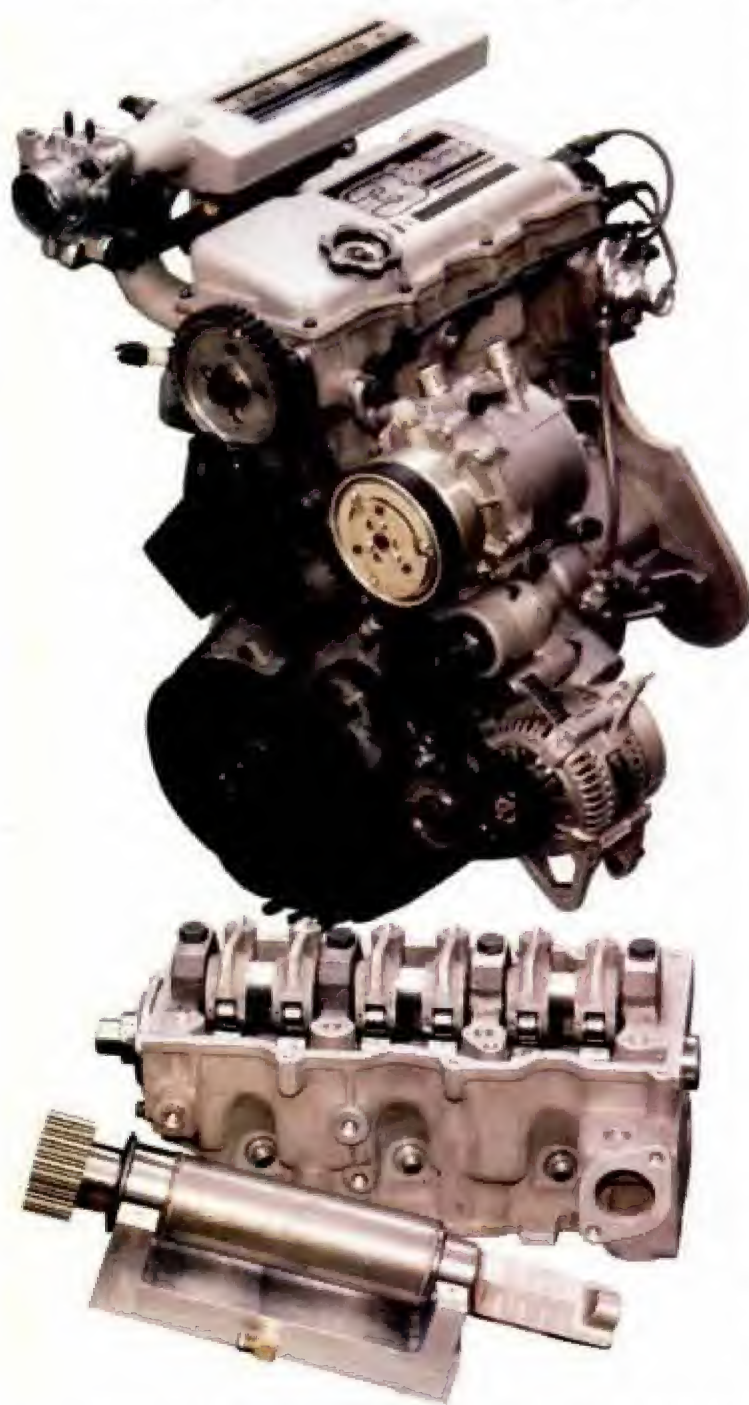
Turbine engine (above) waits for advances in materials technology before becoming a viable option in automotive applications. Experimental GM V6 (left) has individual runners for each of two intake valves per cylinder.



CAR OF THE FUTURE

with its ancestors, but it will have some decidedly new wrinkles.

As we've noted before in this series, the next century may seem to be a long way off. But to powertrain engineers, 2001 is like the day after tomorrow. Designers are already in the final stages of work on engines that will power cars in the mid-'90s. They know exactly what's going to be under the hood of, say, a 1994 model. And even though the automobile engine of the early 21st century is less certain, it isn't exactly shrouded in mystery.



Concept 90 3-cylinder engine by Chrysler, developed for an as-yet unannounced car, uses sleeveless aluminum block, counterbalance shafts, cam low in head for hood clearance.

To see what the future holds for engine technology, PM interviewed powertrain engineers at the major auto companies. We studied existing production engines that incorporate materials or techniques that are on the leading edge of design. And we sifted through stacks of technical presentations to see what engineers are saying to each other. As a result, we came up with a rough idea of mainstream engine technology of the next century.

Gasoline engines predominate

From now until at least 2001, engineers think that the 4-cycle, internal-combustion gasoline engine will reign supreme. And for the most part, that engine will be a recognizable, though highly refined, version of the Four, Six or V8 that's under your hood today. That's right, more than 120 years after Nicolaus Otto built his first 4-cycle engine, the design endures. Continuous refinement of a good basic design has made this possible. "Thinking back 10 years, if somebody said we could have a 1988 Buick Park Avenue, a large car, that goes 0 to 60 mph in 10 seconds and gets 27 mpg, we'd have laughed," says Arv Mueller, who heads powertrain design at GM's B-O-C group. "We have that today, and it's only through refinement that it's possible."

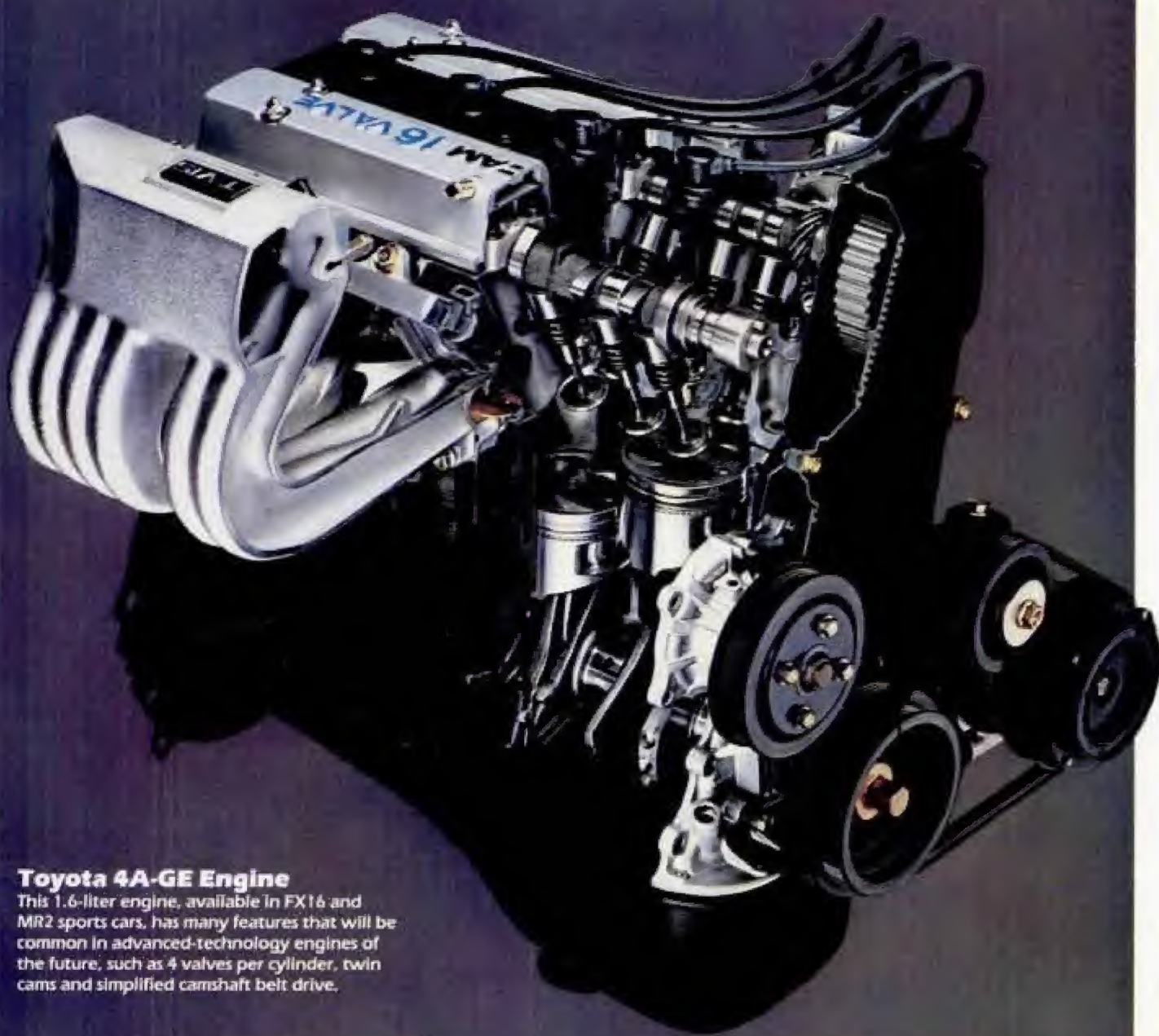
It's a good bet, then, that popular engines of the next century will build on the technology of today. They will incorporate some of the advanced techniques used on current motors of expensive or exotic cars. Here, European makers like Saab with small-displacement, high-output, 4-cylinder turbocharged engines lead the way. BMW with a V12 and Mercedes with a V8 pursue power in a more traditional way—with larger displacement volumes.

The Japanese—particularly Honda and Toyota—are already incorporating leading-edge technology into mid-priced cars. Advanced features like overhead camshafts, aluminum cylinder heads, aluminum blocks, multivalve cylinder heads and fuel injectors for each cylinder are already available on 4-cylinder Toyota Camrys, MR2s and Honda Accords. Even economy cars like the Corolla and Civic are using sophisticated multivalve motors to increase power. With the Japanese pushing the entire industry, these features will be quite common by 2001.

While some of these features sound exotic, they are not necessarily threatening to the do-it-yourself mechanic. A lot of the add-on gadgets that appeared to meet emissions-control requirements will disappear by 2001. Better engine design will allow makers to meet clean-air regulations without such devices as EGR valves, vacuum delay switches or air pumps. Fewer pieces will make it easier to service the rest. And longer component life, coupled with self-diagnostics and unit replacement, might return routine car care to the mechanically inclined amateur.

Prologue to tomorrow

This doesn't mean that there won't be some startling differences under the hood in 2001. But it is to say that the changes will be familiar to those who know existing engines, particularly high-performance European or Japanese engines. And it also doesn't mean that there won't be exotic concept engines or odd limited-production power-



Toyota 4A-GE Engine

This 1.6-liter engine, available in FX16 and MR2 sports cars, has many features that will be common in advanced-technology engines of the future, such as 4 valves per cylinder, twin cams and simplified camshaft belt drive.

plants in 2001, since designers are—at heart—dreamers. It's just that reinventing the internal combustion engine is like reinventing the wheel—possible in theory, but essentially pointless in mass production.

So here's what we think will happen to the subsystems of an internal combustion engine, circa 2001.

■ **Air Flow**—The power is produced in the combustion chamber by the expansion of an exploding mixture composed of roughly 14 parts of air to one part of fuel. If you can get more air into an engine, it's relatively easy to add the needed fuel to make more power. Using more than one intake and one exhaust valve per cylinder helps to make this possible. It increases valve area in the chamber, which improves engine breathing and hence output. Four valves per cylinder is already becoming commonplace, with five and more just around the corner.

Much more work will be done on the intake system that is upstream of the inlet valves. The wide operating range of an engine changes the flow characteristics of the manifold as the throttle moves from idle to full acceleration. Intake manifold passages are currently being split into high- and low-speed runners, with the bigger runners shut at low speeds. This allows a high-flow rate through the manifold even when the engine is using little air. Look for more sophisticated intake systems as makers modulate intake to maximize cylinder filling at all throttle openings.

The new Honda Prelude Si engine provides a good example of the new wave of high-flow induction systems. This 2.0-liter 4-cylinder uses two intake and two exhaust valves per cylinder. A dual-stage intake manifold only opens the high-speed runners above 5000 rpm. Output of the engine is 135 horsepower. That's 67.5 hp/liter, about as



good as you can buy in a \$15,000 car that's street legal.

Force feeding of the mixture is another way to maximize cylinder filling. Both turbochargers (exhaust driven) and superchargers (belt driven) have been around for decades.

"Both turbo- and supercharging are ways to increase the effective displacement of an engine," says Floyd Allen, chief engineer of powertrain systems engineering at Chrysler Motors. "You can develop one powerplant and use it in bread-and-butter applications—then get higher output from the same engine by adding some kind of turbo or supercharger."

How much output? Allen estimates by 2001 that naturally aspirated, multivalve engines will produce a minimum of 60 horsepower per liter of displacement. Force-fed engines will produce at least 100 horsepower/liter. By way of comparison, the naturally aspirated 3.8-liter V6 that powers the 1988 Buick Park Avenue mentioned earlier produces 43 horsepower/liter. A turbocharged 1988 Dodge Daytona Shelby Z 2.2-liter Four has 79 horsepower/liter.

■ **Fuel Handling**—The fuel needed to mix with intake air will be dispensed by injectors. Current problems with injector plugging will be solved with detergents added to the gasoline. It looks like port injection, where there is an injector located in front of the intake valve for each cylinder, will be the most popular system.

Gasoline is still the fuel of choice among engineers, barring some major political disruption in fuel supply. Another political action might require either blending of methanol with gasoline or use of pure methanol as fuel.

It's a long, long shot though: The price of oil would have to approach \$50 a barrel (it's about \$18 now) for a pure alcohol fuel to be competitive. Service stations would have to be changed to accommodate the new fuel. Drivers would have to fill up about twice as often. And engineers would have to overcome cold starting and driveability problems.

■ **Electronics**—The ignition system is already electronic, but higher energy outputs are expected. Computers that regulate the fuel and ignition systems are already here, but there is still a lag in the response time of the controls, explains Ian Macpherson, director in the powertrain engineering office of Ford Motor Co. Computers will get much faster than they currently are.



Twin-turbo Formula One Ford engine squeezes nearly 1000 hp from 1.5 liters of displacement, and uses modified EEC IV computer fuel/ignition management system developed for passenger car use.



Ford SVO V6 racing engine will see service in NASCAR races this season. Based on 3800 V6 used in Thunderbird, it provides horsepower levels of V8s of a decade ago.

Sensors used by the computer will become more sophisticated at the same time. For example, the oxygen sensor now used in the exhaust system to help limit formation of pollutants doesn't measure the pollutants directly. It only measures the chemical proportion of the mixture, and only at one operating point. The engine control computer uses its output to calculate whether combustion inside the chamber is in good order.

Macpherson looks for sensors that can directly analyze the content of exhaust gases so that the computer can adjust the engine to a variety of conditions. The computer will also have the ability to learn from the sensors. Adjustments to the timing or air-fuel ratio will be made based on the engine's current operating conditions, not on calculations made at the time the computer was programmed, years before the car was produced.

■ **Materials**—The all-aluminum engine is already here in some applications, Macpherson notes (including the Prelude mentioned earlier). He expects to see aluminum use expanded by 2001. Other material substitution will occur in both static and dynamic parts. Intake manifolds will be plastic. Internal moving parts such as connecting rods, piston pins and pistons will become lighter by using fiber-reinforced composite materials.

Weight reduction brings several benefits. First, fuel economy is a function of vehicle weight. A lighter engine means a more fuel-efficient car. Second, it's easier to control vibration of lighter parts, so the engine is quieter and smoother. Light parts can also be run at higher speeds, increasing engine efficiency. Weight reduction is, therefore, a major goal of engine builders. Mueller of B-O-C says finding a way to reduce weight in a design is "like discovering gold."

Cost effectiveness

Some of the cost of the more expensive components of future powerplants will be offset by increased production volume. No one is predicting the return of the legendary Ford Model T, whose price steadily dropped as output increased, but all of the makers interviewed were leery of adding cost to the engine just for the sake of technology. The price of fuel-injection systems, for example, is now decreasing as volume builds—so much so that the carburetor will soon be extinct.

Other savings are possible by a concept which will build a family of engines from common components. For example, the multivalve cylinder head of the current Porsche 944 4-cylinder engine is actually a variation of the head used on one bank of the 928 V8. Under a more sophisticated modular engine plan, a basic 3-liter V6 could be split into an inline Three, chopped into a V4 or melded into a V12. Both Ford and GM are pursuing the concept.

Cost reductions will also come from the production process itself, as boring and milling operations become faster or low-pressure casting techniques allow an aluminum head and cylinder block to be made as one unit. A "monoblock," aside from shortening production time and cutting costs, eliminates head bolts and gaskets. These savings might never be apparent to the car owner, but they will be significant nonetheless.

Alternate engines?

"The 4-stroke engine has survived for so long because it has been subject to continuous development," says Ford's Macpherson. "Whenever there has been a threat from a new type of thermodynamic system, continued progress in the 4-stroke design has headed off the competition."

Consider fuel economy. In the past 10 years, the fuel economy of gasoline engines has almost doubled, virtually eliminating the diesel from most future projections.

Then there's the gas turbine. It's a simple, continuous combustion engine (similar to a jet engine) that can burn many types of fuel. When it was first proposed years ago, it looked like a serious challenge to existing designs. It hasn't happened. Turbines are only efficient at extremely high operating temperatures and constant speeds. Expensive materials like ceramics are needed to handle the heat.

"I don't see it in 2001," says Chrysler's Allen. Even though Chrysler was an early proponent of the engine, it's now viewed as an extremely remote possibility. Still, the concept intrigues some. Toyota showed an "experimental gas turbine" at the Toyko motor show last November.

So, if it's historic breakthroughs in engine design you're looking for, our interviews indicate that you're betting against industry insiders. One long shot that could pay off, though, is a 2-cycle, direct-injection gasoline engine, currently a hot concept among engineers.

"There is a chance there will be some 2-cycle powerplants by 2001," says Allen. "Direct injection into the combustion chamber (a kind of high-pressure fuel injection) promises to improve the traditional fuel economy and hydrocarbon emission problems of a 2-stroke."

These problems are caused by having only two cycles. A



Oval-piston Honda racing engine is the ultimate in multivalve technology. The 4-cylinder, 8-valve, twin-plug motor was intended to circumvent rules prohibiting V8 motorcycle engines.

4-stroke engine uses the upward movement of the piston to push out gases on the exhaust stroke. Intake begins on the next cycle. The 2-stroke engine eliminates two cycles. The piston compresses the mixture, using the incoming mixture to push out the exhaust. Some of the unburned mixture is pushed out at the same time, creating pollution and wasting unburned fuel.

"Will a direct injection 2-stroke improve emissions and economy enough to make it a viable powerplant? I can imagine there may be some smaller entry-level cars with 2-stroke engines," says Allen. "But the mainstream cars will still use 4-cycle engines."

The more things change . . .

PM



CHEVY'S DYNAMIC DUO

Pretty faces and friendly prices put Corsica and Beretta on the bestseller list.

CHEVROLET needed a winner. And Chevy dealers needed a stand-out in their showrooms—something with the future-is-now look of Ford's Taurus/Sable twins.

Too many Chevrolet customers were coming in, checking out the (let's face it) fairly bland array of rather stodgy family sedans, then walking out again. Although Celebrity, Cavalier, Nova, Spectrum and Sprint had all established themselves as reasonably solid transportation values, there wasn't one shape in the lot that was likely to increase pulse rates.

Enter a breath of fresh air, Chevrolet's dynamic duo: the Corsica 4-door sedan and the Beretta sport coupe. They're twins under the skin, but they wear different clothes. And they both look attractively distinctive.

Chevy launched the Beretta and Corsica last March, as 1988 models. After a slow start, both cars suddenly got hot, and they're now Chevrolet's (and GM's) best-selling nameplates.

What put them across are two basic attributes: good looks and a decent price. A Missouri contractor, one of 1000 buyers who received our "Owners Report" questionnaires, summed up the overall response when he wrote, "Great styling! My Beretta looks like a sports car, yet it's roomy inside. And I feel I got a good buy. The price was definitely right."

Quality and workmanship also got high marks. A New York instrument technician put it this way: "I work for



Corsica/Beretta engine compartment shows considerable attention to cosmetic detail and clean appearance.

BY MIKE LAMM
Contributing Editor

a company that makes aerospace bearings. My job is to rebuild, repair and calibrate extremely accurate gauges. I work daily with tolerances in the millionths of an inch. I've done this for 21 years, and if there's anything I can judge, it's quality workmanship. This Beretta GT has it written all over it. It's one class act."

An Illinois contractor added, "I consider the Corsica a world-class automobile. It's the best-quality car made for the money today! Materials, workmanship and overall engineering are second to none." He reported that he'd been back to his dealer only for routine service, never for repairs.

Chevrolet did its homework in this area. The manufacturing experts studied Toyota's and NUMMI's assembly operations in Japan and California. Then they totally rebuilt the two plants that now make the Corsica/Beretta.

Care in manufacturing has already paid dividends. Corsica/Beretta me-

chanical problems were fewer than those cited in recent owners reports for Saab, Merkur XR4Ti, Mitsubishi Colt, Taurus/Sable and Hyundai Excel (among others). A retired Iowan reported, "As of yet, there are no bugs."

A relatively large sample of owners (11.8 percent) did their own repairs. This means that their problems were mostly minor, and also says something positive about Corsica/Beretta serviceability. Early Corsicas and Berettas, for ex-

ample, had a habit of letting their rear speakers drop down into the trunk. Even though the 6/60 warranty would have taken care of this—and often did—many owners opted to make new speaker brackets themselves. It was easier than taking the car in.

Those who did need help, though, weren't overjoyed with dealer service. Only 58.5 percent—a lackluster number compared to other surveys—got correct fixes the first time.

Dealer sales policies outshone the service department by a healthy margin. Fully 90.0 percent of our respondents rated their treatment by salespeople as *good to excellent*. A Massachusetts moldmaker confided, "The dealership worked with me one on one. Nobody pushed me into buying anything I didn't want." And that's how most owners felt—that they'd been treated well and had gotten good deals.

Most owners found the Corsica/Beretta contoured front bucket seats comfortable, and a Minnesota architect pointed out that, "I especially like the Corsica's 4-way, driver-seat control, which lets the bottom cushion tilt

Beretta coupe (far left) and Corsica at the Cloisters in New York City.



PM Perspective: Beyond Appearances

ONE OF the soft spots of vehicle testing is the amount of time devoted to the average test subject.

In this sense, there's no substitute for the intimate, detailed experience that goes with ownership, which is precisely why we have Owners Reports, as well as long-term tests.

However, we have a decided advantage over the average owner in all-around hands-on experience.

Accordingly, to make our automotive coverage even more comprehensive, we intend to blend our own staff assessments with those of the owners, beginning with this report.—Ed.

Our response to the Corsica and Beretta is parallel to that of our survey group: These are good-looking cars, and looks are their strongest feature.

In terms of mechanical particulars and general performance, they are undistinguished. But they are nevertheless decent cars with a much better-than-average measure of distinction for the money, and this is hard to argue with.

We recently spent two weeks with a Beretta GT and mid-range Corsica CL, to see if we agreed with the owners in our most recent survey.

Both our cars were equipped with the 2.8-liter V6, as was most of the survey fleet. The V6 provides acceptable acceleration and is well matched to the 3-speed automatic of our Corsica. The Beretta's 5-speed manual raises the coupe's fun-to-drive quotient considerably.

Torque characteristics are good, providing solid low-end response. But

the old pushrod V6 runs out of wind quickly and more than once we detected hints of detonation. This is certainly an adequate engine, but it's dated compared to some of the competing Japanese multivalves.

Back on the positive side, fuel economy was respectable—about 23 mpg for both cars in mostly urban use.

Ride quality, assessed on New York City's mean streets, favors the Corsica's more compliant setup over the Beretta GT's optional F41 suspension. The F41 needed more work in the area of shock tuning for bumpy cornering and body roll was a bit too abundant in both cars.

In our original "Firsthand Drive Report" on these cars (page 160, Feb. '87), we complained that the fit and finish wasn't as good as it could be. We're happy to report this has improved, and the fit and finish of our two test cars was excellent. Neither car emitted a single rattle or squeak.

Inside, we found ourselves at odds with positive owner reviews of seating. The Beretta's buckets, in particular, were average in terms of comfort, adjustability and lateral support.

Interior levels of fit and finish don't seem to measure up to the exteriors, and instrumentation in both cars is just so-so. Our Beretta was equipped with an electronic disco dash that seemed out of place in a sport coupe.

Still, it's a car biz axiom that good looks will carry an otherwise average product, and that's what the owners seem to be reinforcing here.

—Tony Swan



Beretta coupe has the same mechanicals as Corsica, but shares no exterior panels.

to give some leg support." But a few grumbled a bit about rear legroom.

As for ride and handling, most owners agreed with this Massachusetts retiree: "Unusually good ride for a small sedan," he remarked about his Corsica, "thanks largely to the 4-wheel independent suspension." The Corsica sedan can be purchased with F40 or an F41 handling packages (F41 comes standard in LT sedans). And the Beretta gets the F41 or F51 (standard on the Beretta GT) suspension. The F51 includes 15-in. steel wheels, wider tires and a wider rear stance, heavier rear sway bar, and tighter shock settings.

"The GT rides a little firmer than other models," opined an Ohio cost accountant, "but I like it."

In terms of performance and road-holding, a New York quality-control manager volunteered, "The optional and loves the open road. My Corsica handles nicely, too, and has put the fun back into driving. This is the first Chevy product I've owned that I'm totally pleased with."

As for fuel economy, most owners smiled all the way to the pump. The Corsica/Beretta lives up to and, in some instances, exceeds its EPA esti-



Even interior treatments are completely different between the two sister cars.

mates (see data panel). A Wisconsin engineer: "Gas mileage is exceptional, even when jackrabbiting through traffic. And, finally, here's a car that's fun to drive."

We heard complaints about the instrument panel intruding into the passenger area, that the ledge on the passenger's side should be wide for a can

of soda, and an Illinois nurse noted that, "... regulating the temperature control often resets the radio." A few owners found the radio difficult to operate while driving.

Then, too, a New York construction worker was among those who pointed out: "The shoulder harness tangles in the seat-recliner lever, causing the seatback to fall rearward when the driver tugs on the seatbelt." Several drivers let us know that various switches don't light up at night, and a Kentucky salesperson asserted, "The console stands too low to be used as an armrest—should be raised 6 in." Drivers praised the drawer-like locking glovebox, however, and the many storage bins in both cars.

All told, owners had a lot more good things to say about their cars than

bad. A Tennessee supervisor noted, "The style, economy and performance are comparable with European cars costing \$20,000 and more."

A Nebraska policeman: "The Beretta comes close to having all the standard items I look for in a car, things like 2-side galvanized sheetmetal for the entire body, AM/FM stereo with built-in digital clock, headlamp warning chimes, basecoat/clearcoat paint, power rack-and-pinion steering—all those little things that make the difference."

And a New York technical assistant: "I feel my Corsica combines stylish looks with fine performance and solid comfort. These attributes, along with the service I've grown used to from my local dealer, make me a very satisfied customer." **PM**

SUMMARY OF 1988 CHEVROLET CORSICA/BERETTA OWNERS REPORTS*

Total miles driven	975,291	Option choices:		More powerful engine	4.1	No	41.5
Average miles per gallon:		Air conditioning	95.5%	Bigger fuel tank	4.1	Dealer service opinion:	
2.0-liter with 5-speed manual transaxle:		Beretta GT package	61.8	How much did you pay?		Excellent	41.4%
In town		Corsica LT package	50.5	Average	\$12,076	Good	43.0
(EPA est. 25 mpg)	27.2	Why did you choose the Corsica/Beretta?		Range	\$9300-\$16,000	Average	10.2
On the highway		Styling	85.1%	Workmanship opinion:		Poor	5.4
(EPA est. 35 mpg)	32.9	Price/Value	25.4	Excellent	57.0%	Number of vehicles owned:	
With 3-speed automatic transaxle:		Handling	17.7	Good	37.8	This car only	41.0%
In town (EPA est. 24)	24.8	Performance	11.7	Average	3.7	Two cars	34.7
On the highway		Comfort	8.5	Poor	1.5	Three cars	12.9
(EPA est. 31)	31.1	Specific likes:		Comfort opinion:		Four or more cars	11.5
2.8-liter with 5-speed manual transaxle:		Styling	72.9%	Front seats: Excellent	62.0%	Makes of other cars owned:	
In town (EPA est. 19)	21.9	Handling	40.8	Good	31.4	Chevrolet	65.0%
On the highway		Economy	31.0	Average	3.6	Ford	21.9
(EPA est. 29)	28.9	Comfort	29.0	Poor	2.9	Oldsmobile	18.1
With 3-speed automatic transaxle:		Riding qualities/Power	19.6	Rear seats: Excellent	37.8%	Plymouth	9.4
In town (EPA est. 20)	21.1	Specific dislikes:		Good	45.8	Pontiac	6.2
On the highway		No complaints	17.7%	Average	14.1	Would you buy a Corsica/Beretta again?	
(EPA est. 26)	26.3	Seats aren't comfortable	9.6	Poor	2.3	Yes	57.6%
Body-style/nameplate choices:		Rattles and noises	8.6	Had any mechanical trouble?		No	7.1
Beretta 2-door coupe	53.3%	Layout of a/c, radio controls	5.7	No	71.4%	Maybe	35.3
Corsica 4-door sedan	46.7	Harsh ride	4.8	Yes	28.6	Would you buy Chevrolet again?	
Engine choices:		What changes would you like?		What type of trouble?		Yes	65.3%
2.8-liter V6	62.2%	No changes	27.6%	Electrical	15.8%	No	4.5
2.0-liter Four	37.8	More rear-seat roominess	10.0	Air conditioning	14.5	Maybe	30.2
Transaxle choices:		Change console height	6.8	Shifter	6.6	Age distribution of owners:	
3-speed automatic	80.2%	Better a/c, radio controls	5.4	Brakes/cruise control	5.3	Under 29 years	29.2%
5-speed manual	19.8	Make intermittent wipers standard	4.5	Power windows	5.3	30-49	39.0
				Dealer repairs satisfactory?		50-plus	31.8
				Yes	58.5%		

*Percentages might not equal 100% due to rounding or insufficient quantity of data.

GOLD

Modern technology is replacing hard labor in wresting the precious metal from the Earth.

BY BRUCE MOST

HIGH on the flanks of 12,500-ft.-high South Mountain, very near Summitville in the San Juan range of southern Colorado, the remains of old buildings and abandoned mine shafts stand as mute testimony to the gold and silver mining that once flourished here. From 1873 to 1942, hard-rock miners chipped 300,000 tons of ore and 262,000 ounces of gold out of such mines as Little Annie and Iowa, before the mountain was played out.

Today, a new generation of miners have returned to South Mountain, bringing with them the latest mining technologies to profitably work the old sites. Operating 24 hours a day, 7 days a week, the Summitville Mine, the property of Galactic Resources, Ltd., of Vancouver, British Columbia, is one of the largest and most sophisticated heap-leach gold mining operations in the world. During its anticipated mine life of six to seven years (exploration may yet extend that life), Summitville will have moved 18-million tons of open-pit, low-grade, gold-bearing ore, some of it gouged from the very seams the hard-rock miners worked 100 years ago. Those 18-million tons will yield 550,000 ounces of gold and 250,000 ounces of silver.

Galactic's Summitville operation typifies the 1980s resurgence of gold mining in the United States, much of it in the old Gold Rush sites of the West. "Exploration is booming all along the Pacific Rim," says John Lucas, a gold specialist with the U.S. Bureau of Mines. "People are reexamining sites that were previously dismissed because of their low gold content. The new technologies are making some of them valuable."

Valuable, indeed. According to figures from the Bureau of Mines, domes-



GALACTIC RESOURCES PHOTOS

RUSH!

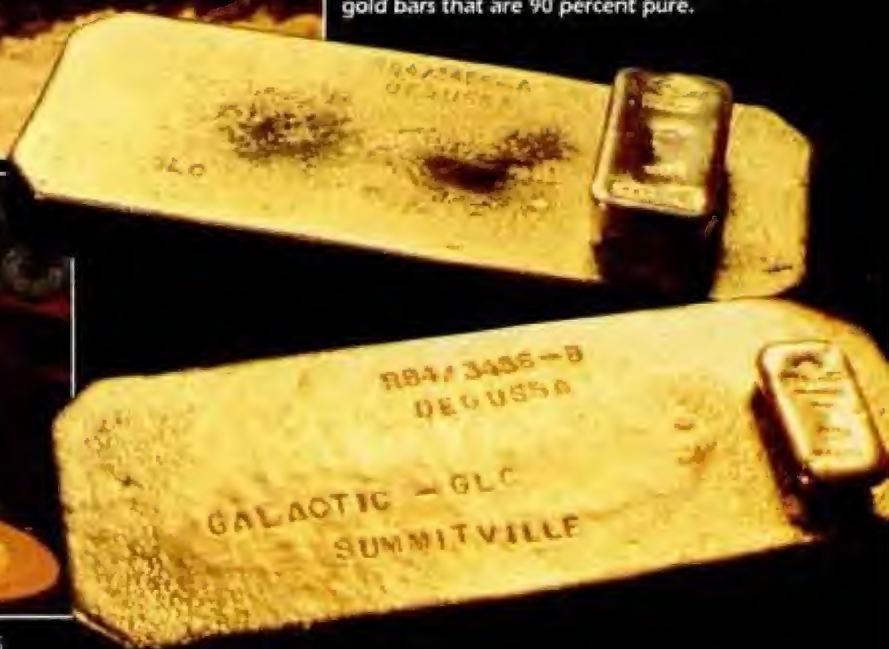


tic gold mine production increased 40 percent from 1985 to 1986, with 40 new mines opening, mainly in Nevada, California, Idaho and Colorado. Some 80 percent of the mineral exploration in the nation is now devoted to gold. The Bureau estimates 1987 domestic gold production to be 4.2-million Troy ounces, up nearly half a million ounces from 1986, moving the United States ahead of Canada as the third largest gold producer in the world.

Why this latest gold rush? Why are the once-abandoned Little Annie mines suddenly hot properties? The strong demand for gold coins such as the new American Eagle, the unstable political situation in South Africa which produces 40 percent of the world's gold, rising gold prices, and low prices for metals such as copper and uranium have sparked the resurgence.

But no small factor has been the driving force of technological innovations, especially in gold recovery techniques, which have dramatically lowered production costs. No sour-

Modern gold mining has replaced the prospector's pick with a variety of high-tech refinements: Twin conveyors (left) transport crushed ore to a cyanide heap-leach pad in background. From left to right below: A single control panel oversees ore movement. Strip tanks separate gold from carbon/pulp slurry. Molten gold results in gold bars that are 90 percent pure.



PM PHOTO BY DOROTHY TANIGUCHI

GOLD RUSH!

dough prospectors are leading this gold rush. The new prospectors are freewheeling entrepreneurs, heading up large companies eager to try or develop new technologies. (Galactic's CEO, Robert M. Friedland, once ran an organic apple orchard with computer king Steven Jobs.)

Leading the gold recovery technologies is heap leaching. In its most common form, heap leaching involves the spraying of a weak solution of cyanide over a "heap" of gravel-sized crushed ore. The solution filters down through the pile leaching, or chemically absorbing, the microscopic particles of gold. The solution is then processed to extract the gold. In traditional gold milling, the ore must be pulverized to the consistency of baby powder before being processed in large flotation tanks, a milling procedure that is very expensive compared to that of heap leaching.

Heap leaching is actually a 100-year-old process that's been used effectively in the mining of copper and uranium. Only in the past decade, following research by the U.S. Bureau of Mines, has it been applied to the recovery of disseminated gold from low-grade, near-surface ore deposits. Technological improvements have lowered heap leaching production costs to less than \$200 an ounce, compared to \$300 for conventional milling. Not bad at a time when the spot market price for gold has hovered around \$400 an ounce. Little wonder that heap leaching now accounts for 30 percent of the extracted gold in the United States, up from 6 percent in 1980.

"Heap leaching has been an important factor in precious metals recovery because it permits utilization of lean ores and wastes that are not economically processed by conventional agitation cyanidation," says Judith Eisele, a research supervisor at the Bureau of Mines' Reno Research Center.

The ore is first brought to the crushing plant, where a rotating crusher grinds 25,000 tons of ore daily to 7 in. or smaller pieces. Secondary crushers reduce the ore to 1½-in. pieces.

From there the ore is trucked onto a specially designed leach pad. The 45-acre leach pad, which can be expanded to as large as 108 acres, looks like a huge shallow bowl carved out of

the landscape. The pad is constructed with 2 ft. of compacted clay, overlaid by sand, two high-density polyethylene liners, and an industrial-strength woven fabric on which the ore is heaped.

After the ore is dumped onto the pad by the trucks, and leveled by bulldozers, a weak cyanide solution (.05 percent) is sprayed over the ore. The solution percolates to the bottom of the pile, leaching out gold on the way, and collects in three pump wells. From there the pregnant solution is pumped to the processing plant at the rate of 500 gallons per minute.

The gold-bearing solution is circu-

filters to remove the precipitate. Mixed with flux, the precipitate is put into a 2300° furnace and smelted into doré bullion bars, which are shipped out for refinement and eventual use in jewelry, coins, industrial applications and to be stockpiled as currency reserves by governments.

While heap leaching is relatively inexpensive and uncomplicated, it is not without its drawbacks. The method typically recovers only 75 percent to 80 percent of the gold, compared to 90 percent for more traditional milling operations. Heap leaching does not work well in cold temperatures—Galactic mines at Summitville only seven

months out of the year. Smokey Valley Mining Co.'s gold operation in Nevada is now heating its leaching solution prior to its introduction on the leach pad, enabling it to operate on a year-round basis.

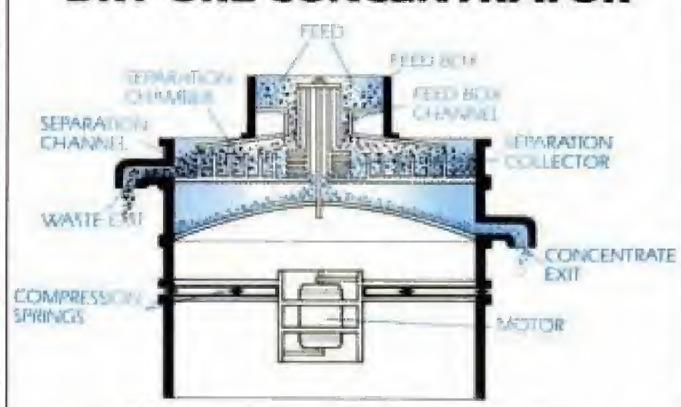
Heap leaching is not effective for certain types of ores, such as refractory ores (contaminated ores, especially with sulfides, that prevent efficient processing) and those high in clay. One approach to refractory ores, as well as a way to avoid some of the environmental problems associated with cyanide, is the application of noncyanide leaching agents such as thio-urea, bromide and ammonium thiosulfate, though to date industry experiments have produced no cost-effective substitutes. Troublesome clayey ores prevent even percolation of the cyanide solution, a problem the U.S. Bureau of Mines has overcome by agglomerating, or mixing, the ores with a bonding substance such as Portland cement.

While heap leaching is commanding most of the attention, more traditional gold-recovery technology is not without its innovations.

At the huge \$280-million McLaughlin Mine 70 miles from San Francisco, run by Homestake Mining Co., preliminary assaying showed that gold recovery would be low with conventional methods because of high sulfide content. So Homestake spent three years researching and designing large autoclaves to bake the ore under high pressure, intense heat and a pure-oxygen atmosphere to hurry up nature and oxidize the sulfides before crushing. They are now able to recover 90 percent of the gold. Private researchers are also looking at



DRY ORE CONCENTRATOR



Processing gold in two different environments: Leaching pit at Galactic Resources' Summitville mine (top) is suitable for water-rich Colorado mountains. Mineral Recovery Corp.'s dry concentrator (above) "pans out" gold in deserts.

lated through a series of columns filled with activated granulated charcoal made from coconut shells. The carbon absorbs the gold and is then transferred to heated pressure tanks where a caustic solution of sodium hydroxide and sodium cyanide strip the gold from the carbon. (The barren cyanide solution is regenerated and returned to the leach pad.) Powdered zinc is injected into this enriched stripper solution and precipitates out the gold and silver oxides. The resulting slurry is pressed through paper

the use of bacteria to accelerate the oxidation of sulfide ores.

The U.S. Bureau of Mines is responsible for another modern gold-processing technique known as carbon-in-pulp. One traditional method of separating gold from pulverized ore involved time-consuming settling, expensive solid-liquid separation, and clarification of the solution. In a joint experiment with Homestake at their Lead, South Dakota, plant, the Bureau solved the problem by leaching the gold in a thick, agitated carbon slurry. The carbon containing the gold can then be easily screened out.

Gold mining may also be able to expand into arid regions because of another advance in processing: the dry concentrator. Gravity concentrators, which normally use water and motion to separate out the heavier gold particles, much as a gold pan does, have traditionally been used in large "placer" mining operations, mostly in Alaska. Because these concentrators require lots of water, however, they've rarely been economical in arid regions. Now Mineral Recovery Corp. in Pleasantville, New York, headed by a 72-year-old former Wall Street executive named William J. Haight, has developed a dry concentrator that spins the particles 1800 times a minute and uses a unique set of channels and baffles to separate and concentrate the gold-bearing ore.

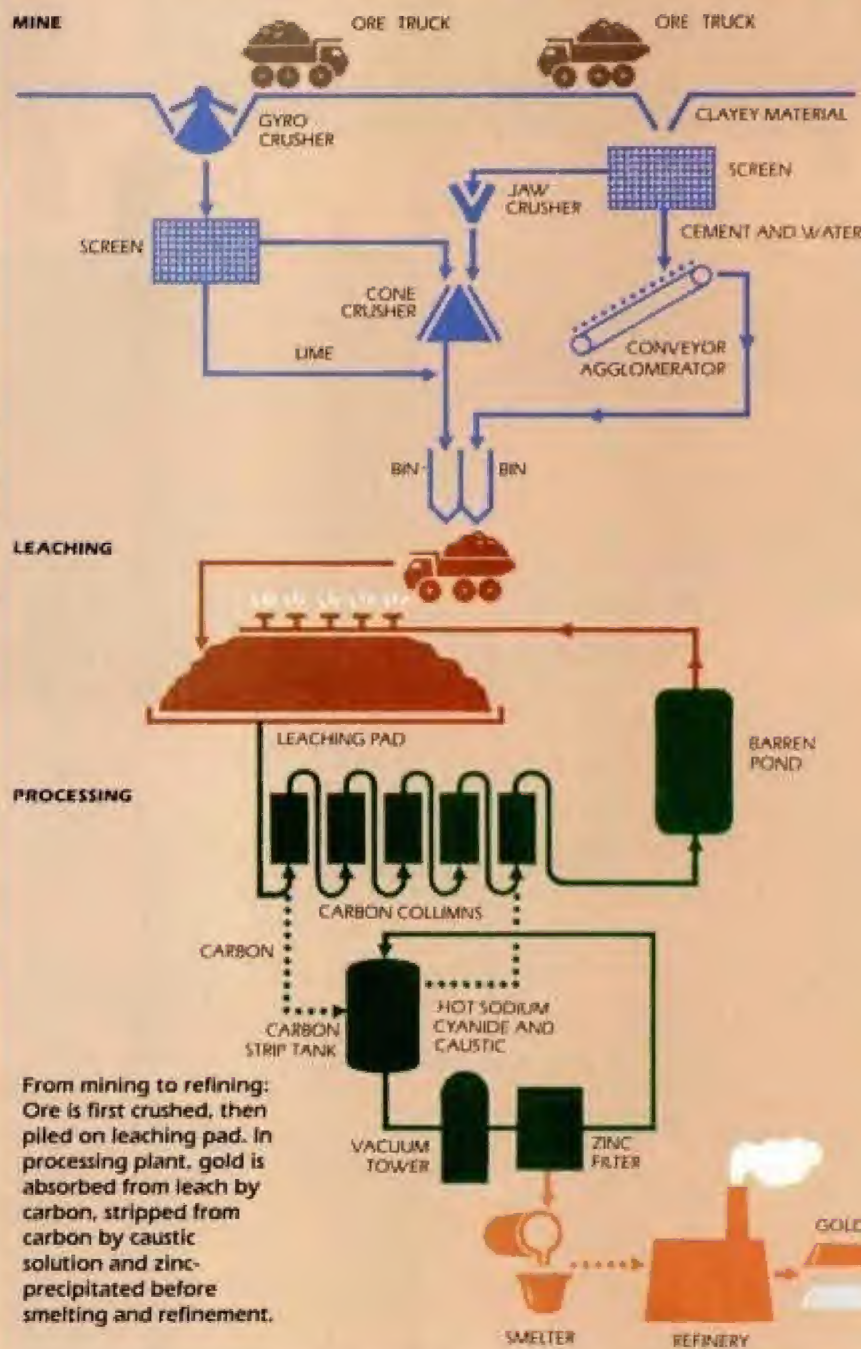
The resurgence of gold mining, and especially heap leach mining with its huge pits of cyanide solutions, has sparked new environmental concerns for the mining industry. When the McLaughlin Mine was built, for example, Homestake had to obtain 270 environmental permits from three counties and state and federal authorities before construction could begin.

Currently, most leach pads such as that at Summitville will be capped with clay, topsoil, and reclaimed. Sonora Gold Corp.'s Jamestown Mine at Whiskey Hill, in the historic Mother Lode country of California, is computer-monitored for leaks. But the question remains, what does one do with the leftover cyanide solutions and other mining-related hazardous wastes?

Probably the most exciting technology to appear is the use of biological systems to treat the toxic effluent. After Homestake Gold Mine found that chemical and physical methods for cleaning up waste waters pumped out of its huge Lead, South Dakota, mine were ineffective, Homestake experimented with and eventually built a treatment plant using bacteria to break down contaminants.

A "biosorbant" biological technology developed by Advanced Mineral Technologies, Inc., is commercially

HEAP LEACHING: REPLACING PICK AND SHOVEL



available as AMT-BIOCLAIM, which can remove heavy metals from mining effluent. The metals can then be reclaimed and the granules reactivated for reuse.

Such new technologies may quiet environmental concerns, something the industry certainly desires, as it wants nothing to impede this latest gold rush. Galactic's Robert Friedland sees the current gold boom lasting at least the next three to four years. "With production costs at around \$200 an ounce and gold selling at more than \$400, the industry is growing by leaps and bounds. And the impact of the technology has been dramatic—very dramatic."

PM

Worker stamps serial number on 90 percent-pure doré bullion bar—the final product of gold processing before refinement.



HOW WE'LL LIVE



NASA planners foresee a manned lunar base in the early 21st century. Why are we going back? And how will we survive when we get there?

BY ISAAC ASIMOV
PM Illustrations by Pat Rawlings

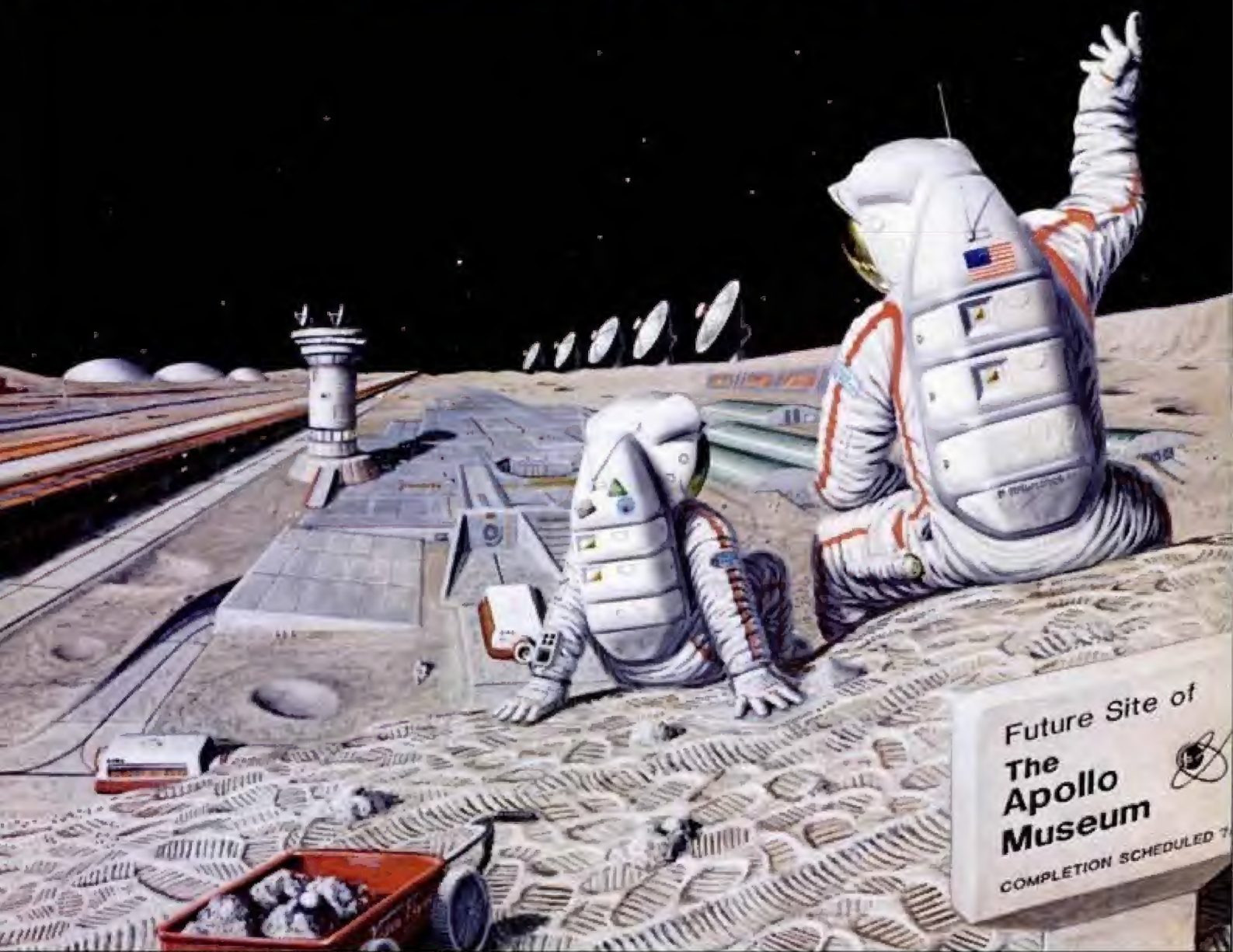
ABSOLUTE SILENCE.
The Lunarian stood in the eternal dark within the crater at the Moon's south pole,

and thought that silence was what was so characteristic—and soothing—and, yes, frightening—about the Moon. He was not a true Lunarian, of course. He had come from Earth and when his 90-day stint was over, he would return to Earth and try to readjust to its strong pull of gravity.

There was no motion anywhere, no sound of living things. There was light along the crater top, as perpetual as the dark at this portion of the crater floor. Farther along the gently rolling floor, in the direction of the opposite side of the crater, was sunlight, too.

The Lunarian looked in that direction, and the photosensitive glass of his faceplate darkened at once.

ON THE MOON



The line between dark and light swung slowly toward him and away in a 4-week cycle. It would never quite reach the point where he was standing, nor ever quite recede out of sight. If he were to move a few miles into the light, he would see the Sun skimming the crater edge along the horizon, but, of course, the faceplate grew virtually opaque if he accidentally looked in the Sun's direction. At intervals, he could see the Earth, or a portion of it, edging above the crater wall. His heart would always melt at that sight. He tried not to think of Earth. For now, he was on the Moon. He could make out the line of photovoltaic cells in the sunlight and he knew that solar energy, never-ending, was

Two Lunarians contemplate Mother Earth from a crater rim overlooking an advanced Moon base. The facility boasts an electromagnetic tube launcher to hurl mined lunar oxygen into space, observatories and complex structures housing labs and life support. This vision could be reality by the end of the next century.

powering the world beneath his feet—which was, as yet, very small. Already, dozens of human beings were housed there and in his lifetime it might well rise to hundreds. An experimental farm existed there, plus a chemical laboratory for the study of lunar soil, a furnace for baking out the small but precious amounts of volatile elements from appropriate ores.

This was not the only Moon base. A much larger one

LIVING ON THE MOON

existed near the lunar equator, where the soil was mined and hurled into space to be used as a construction material. A much more specialized one existed on the Moon's far side where a huge radio telescope, insulated from Earth's radio interference by 2000 miles of solid Moon, was being completed.

The Lunarian thought: It is the year 2028 and the Moon has become our second world.

But it is now 1988. We have visited the Moon six times between 1969 and 1972, and 12 men have trod its surface. But those were visits only. We came, lingered and left—so that the total time human beings have spent on the Moon is less than two weeks.

But we have been sharpening our space abilities, and when we return to the Moon, it will be to stay. A day will come in the future after which there will never be a time when human beings will not be living on the Moon.

NASA is already planning Moon bases. In recent years, scientists, engineers, industrialists and scholars have met to discuss scientific, industrial and sociological issues in connection with living on the Moon. Former astronaut Dr. Sally K. Ride, America's first woman in space, recently produced a report outlining this nation's space goals. Satellite studies of the Earth will remain an important priority, along with the lofting of un-

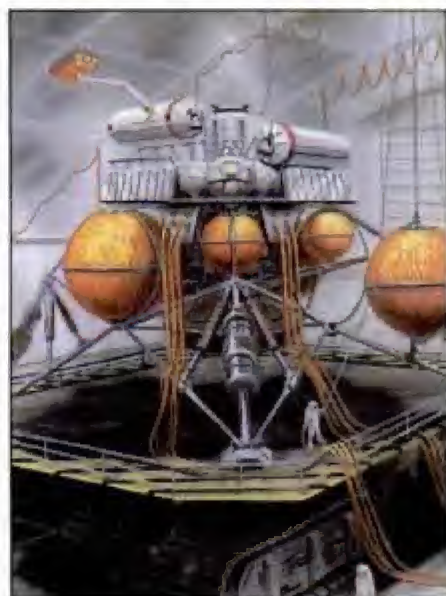
manned spacecraft to explore our solar system. But the "Ride Report" also stresses a manned permanent presence on the Moon before we embark on a manned mission to Mars, hoping to fully exploit the Moon's resources and scientific opportunities—while boosting our own interplanetary learning curve—before engaging in a Mars space spectacular.

Whether or not we choose to follow the Ride recommendations, the Moon will probably play an important role in man's future space explorations. But

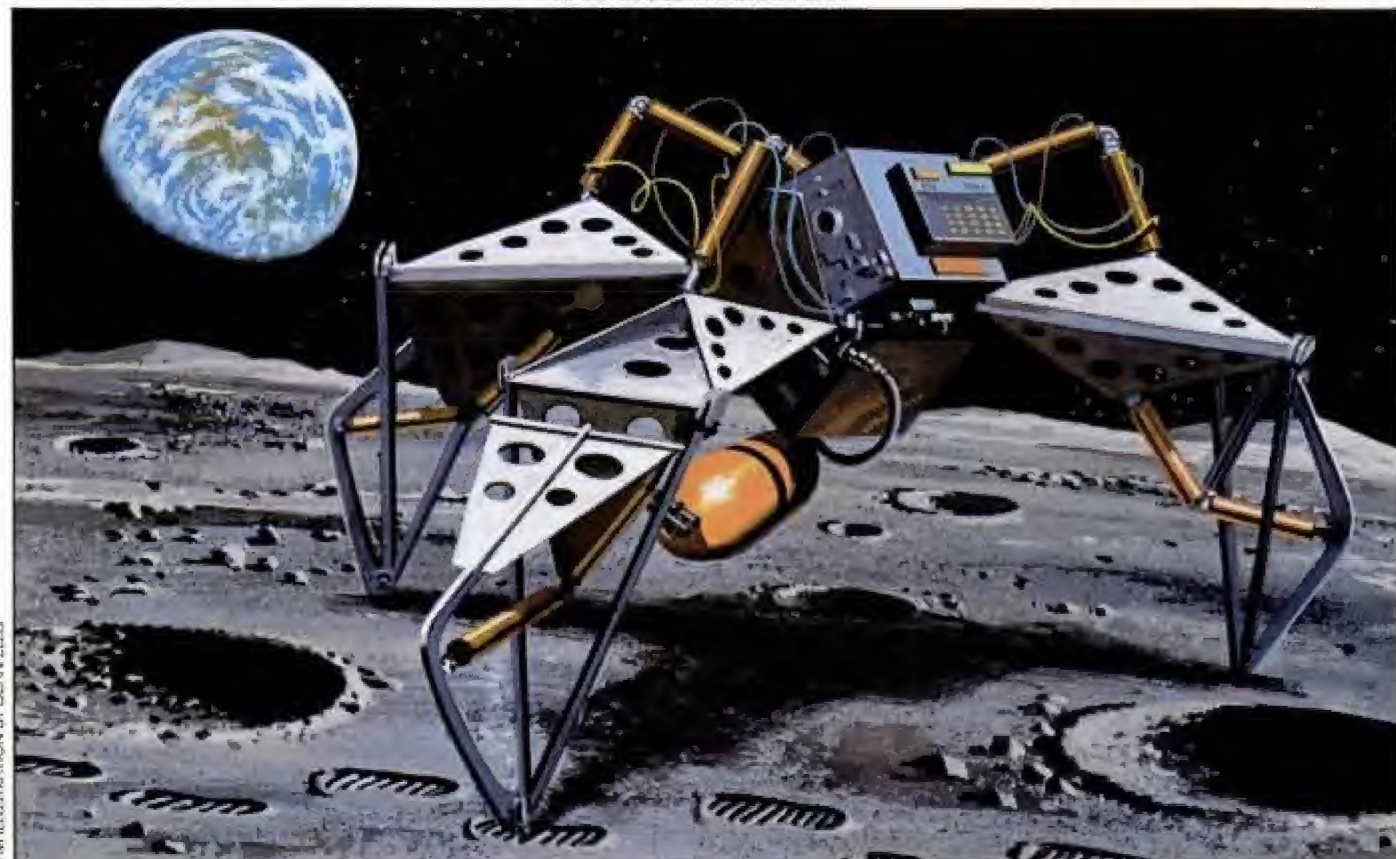
why bother? The Moon is a dead, desolate world, without air or water. It is a large super-Sahara. So what is there to make us want to go there, let alone live there?

Super-Sahara or not, the Moon would be useful, even vital, to us in many ways. Some of those ways are not material in nature. For instance, there is the question of knowledge. The Moon has not been seriously disturbed after the first half-billion years of the existence of the solar system (something that is not true of the Earth). We have been studying 800 pounds of Moon rocks astronauts retrieved, but merely bringing them to Earth has contaminated them, and the astronauts were only able to investigate isolated landing areas. If we can investigate the Moon's substance on the Moon, over extended periods and over every portion of its surface, we might learn a great detail about the early history of the Moon—and, therefore, of the Earth as well.

Unlike man's initial forays to the lunar surface, future trips to the Moon will be greatly aided by a space station positioned in low Earth orbit, by orbital transfer vehicles and by expendable lunar landers. It's envisioned that early lunar pioneers will reside in pressurized modules and airlocks—not unlike the modules currently being designed for the space station—but with a significant difference. Because the Moon has no protective atmosphere, early settlers will cover their modules with up to 2



A lunar lander (above) delivers cargo pods to a future Moon base. To assist in lunar exploration, engineers at Georgia Tech have designed Skitter I (below) a 3-legged, all-terrain, autonomous robot.



PM ILLUSTRATION BY DEAN ELLIS



meters of lunar soil, or regolith, to protect them from solar radiation. These modules may give way to larger structures positioned beneath regolith archways or buildings made of lunar concrete as requirements change. Indeed, lunar building materials may one day be a principal lunar export.

Solar collectors, photovoltaic systems and small nuclear powerplants positioned well away from lunar habitats would supply the power needs of an early Moon base. The resulting energy would support not only human explorers but a broad array of science and industrial activities, principally lunar mining and astronomical observation. Wheeled lunar rovers powered by the Sun would provide close-in transportation and cargo handling. Vertically launched rocket vehicles would aid in mapping and distant exploration. Some tasks may be performed by intelligent robots already on the drawing board.

After humans become established on the Moon, some visionaries foresee a complex of habitable dwellings and research labs for geochemical, physical and biological research. A life-giving atmosphere "manufactured" on

An astronomy research lab with a crater-mounted radio telescope (top illustration) is located near the Moon's south pole. A regolith collector (above left) gathers oxygen-rich lunar soil. Lunar homelife (above right) is made comfortable by a domestic robot, flat-panel TV and pleasurable vistas of hydroponic gardens.

the Moon would promote ecological and agricultural pursuits, helping to make a Moon base self-supporting. Turning to the heavens, special detectors would analyze rays from astrophysical sources, and Moon-based particle accelerators would give new insight into the nature of matter. Special units would process oxygen and refine new ceramic and metallurgical materials. "Moonmovers," adapted from Earthmovers, would excavate building and mining sites.

To what purpose? First, but not necessarily foremost, the Moon is a marvelous platform for astronomical observations. The absence of an atmosphere makes telescopic visibility far more acute. The far side of the Moon would allow radio telescopes to work without interference from human sources of light and radio waves. The Moon's slow rotation would allow objects in the sky to be followed, with-

out interference from clouds or haze, for two weeks at a time. Neutrinos and gravity waves, together with other exotic cosmic manifestations, might be detected more easily and studied from the Moon than from the Earth. And, in fact, radio telescopes on the Moon and on the Earth could make observations in combination, allowing us to study in the finest detail the active centers of the galaxies, including our own Milky Way.

The Moon can also be used for experiments we would not wish to perform in the midst of the Earth's teeming life. Think of the genetic engineering we could perform, of the experimental life forms we could devise. We could obtain energy in copious quantities for use not only on the Moon, but for transfer to space structures and even to the Earth. Think of the nuclear power stations we could build (both fission and, eventually, fusion) where safety considerations did not bulk so large. Think of the efficiency of the solar power stations we could build on a world without an interfering atmosphere to scatter, absorb and obscure light.

From the Moon's soil, we would ob-

(Please turn to page 116)

REEL VALUE

Old fishing tackle is fast approaching classic status and will one day soon be worth a lot more than memories.

BY JIM BASHLINE; Photo by Spencer Jones

Old fishing reels stir old memories. If you ask a fisherman to place a value on a fishing reel, it's not surprising that most will measure it in terms of fish. Fish caught or lost. Memories of legendary angling adventures.

But a small number of enthusiasts measure reel value differently. They balance nostalgia against availability and arrive at dollar figures that range from \$25, for a South Bend Oreno (circa mid-1940s), to \$1200, for an old J.A. Cox big-game reel known as the Zane Grey.

These fishermen are reel collectors, a rare but growing breed. Unlike most scaly-handed veterans of fresh or saltwater battles, who leave their old reels lying around the garage or basement, collectors keep accurate records of when and where their reels were acquired. They hold onto

(Please turn to page 130)



Today's collectibles, such as those shown here, range from less than \$10 for a 1947 Horrocks-Ibbotson Vernley to more than \$300 for a 1900 Hendryx salmon reel. These low prices will soon rise.

1931: Bronson Biltwell model No. 2800, a popular baitcaster;

1947: Horrocks-Ibbotson Vernley model made of Bakelite hard rubber;

1961: Garcia Ambassadeur 5000, a Swedish-made baitcaster;

1920: Penn 85, a saltwater jigging reel;

1900: Hendryx Salmon, a big brass reel made in England;

1935: Shakespeare Russell, a classic American fly reel.



1900

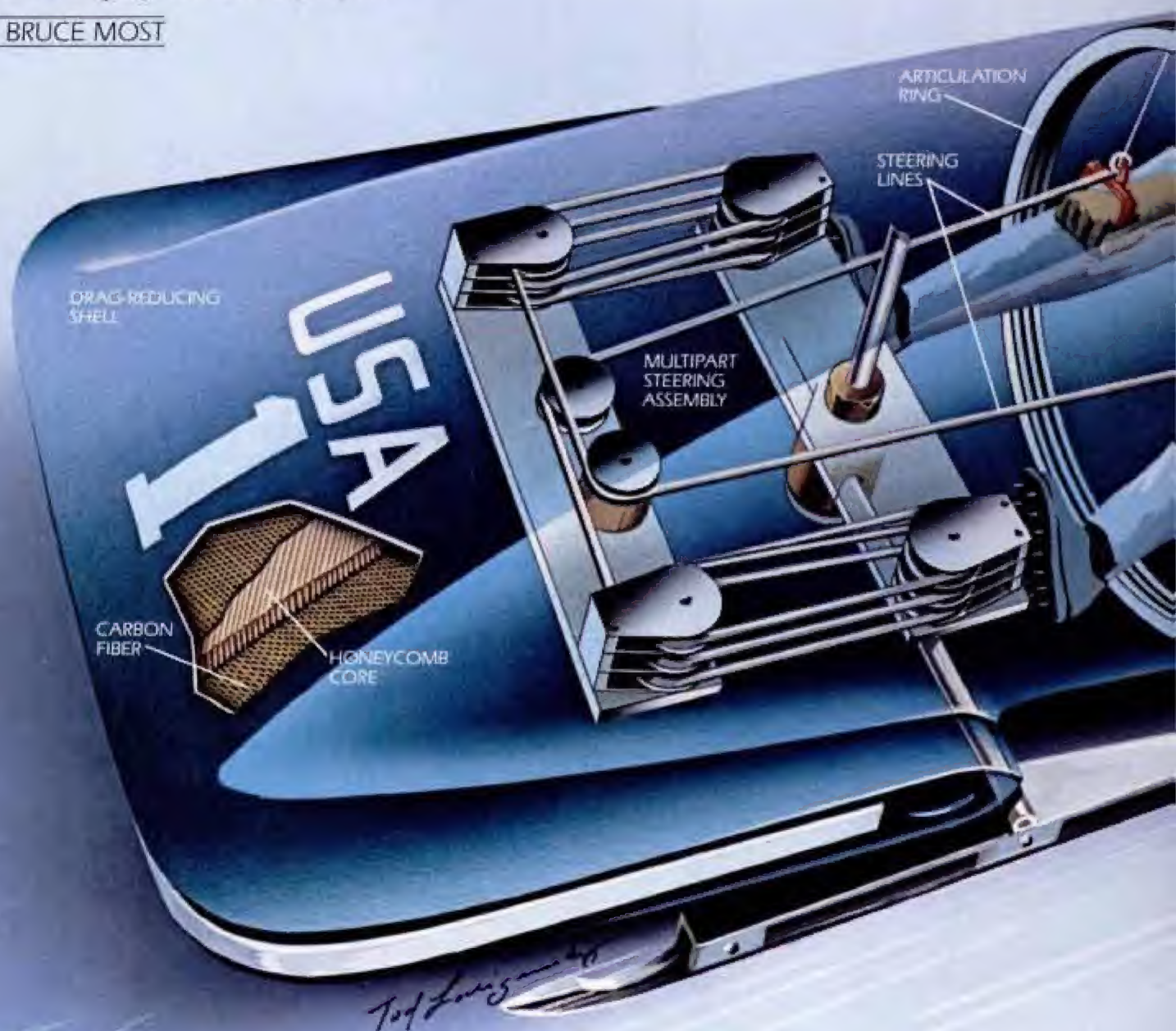
1920

1935

GOLD MEDAL

New lightweight, high-strength equipment will join the action at the Calgary Winter Olympics.

BY BRUCE MOST



WHEN it comes to high tech, America can put a man on the Moon—but it can't build a respectable bobsled. That, anyway, has long been the rap against American Olympic efforts. Soviet-led East Bloc Olympians have long been rated the leaders in high-tech and medium-tech Olympic sports such as bobsled, biathlon, skating, archery and shooting. American sports technologists have lagged behind in such basic research as aerodynamics, bioengineering and materials science.

But all that is changing, and the first evidence of that change will be seen at the 1988 Winter Olympic Games in Calgary, Canada. Back in 1983, the U.S. Olympic Committee, recognizing the desperate need for better performing and safer equipment for its athletes, formed the Sports Equipment and Technology Committee to provide funding

and to act as a liaison between the individual sports, industry and government. Results of that effort will be seen in such sports as the bobsled, biathlon and other winter events. Some examples:

Bobsled

In Livonia, Michigan, Airflow Sciences Corp. (ASC), a consulting engineering firm specializing in fluid dynamics, illustrates the new emphasis on technology with a revolutionary approach to designing 2-man and 4-man sleds for the U.S. Olympic team. Using automotive modeling clay, wind-tunnel testing, and employing the same construction technology for building Indianapolis and Formula 1 race cars, the firm, by late 1987, had achieved a 42-percent reduction in drag in the 2-man sled and a 44-percent drag

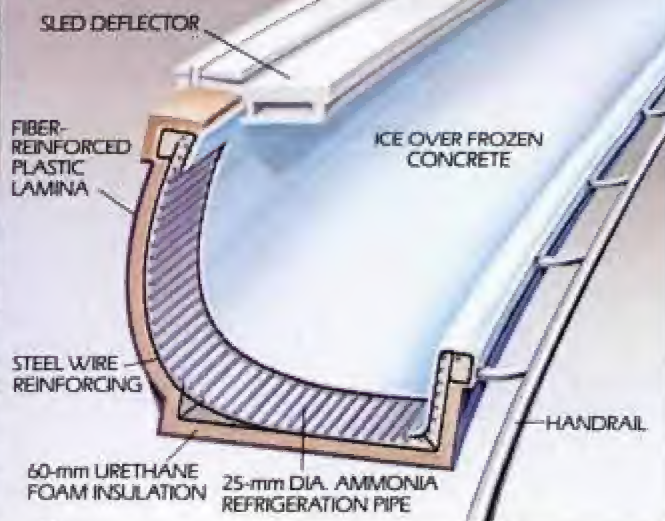
GEAR



BOBSLED REVOLUTION

The Airflow Sciences 2-man bobsled reduces drag by a dramatic 42 percent. Innovations include a composite monocoque construction that eliminates the heavy steel chassis. Calgary's bobsled/luge track (below) features a 360° turn where competitors pull up to 4½ Gs. Pressurized ammonia gas can maintain ice up to 72° F.

BOBSLED/LUGE TRACK



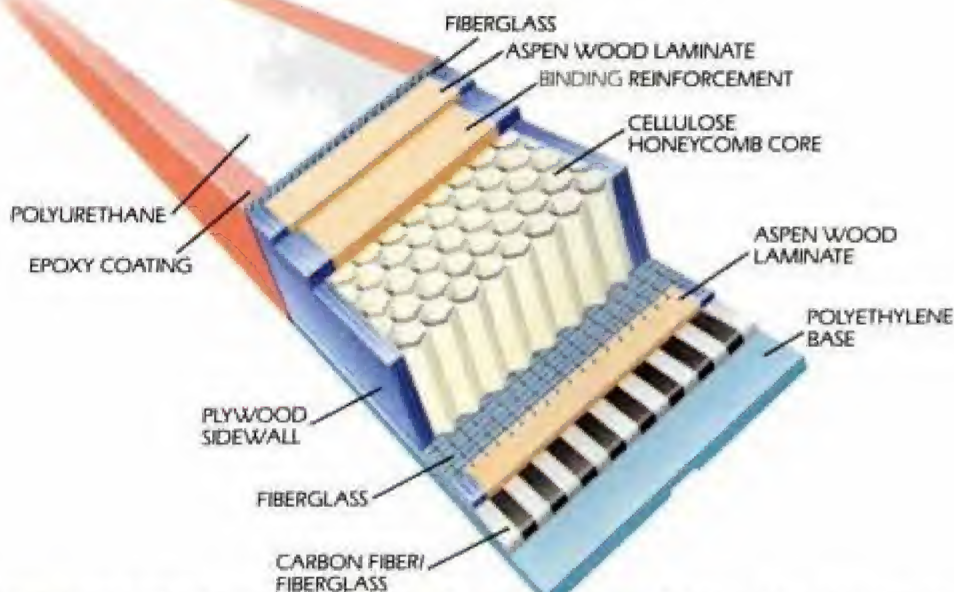
reduction for the 4-man, compared to the 1984 Winter Olympic baseline sleds.

Among the more radical design changes was the replacement of the old welded-steel chassis with a high-strength, fiberglass composite of Nomex honeycomb, sandwiched between layers of graphite/Kevlar cloth with epoxy resins. The molded body increases design flexibility while reducing weight. More weight reduction and greater strength has also been achieved by the use of corrosion-resistant titanium instead of steel for the sled's suspensions and axles.

Bobsled teams always want to run their sleds at maximum allowable weight (827 pounds for the 2-man, 1389 for the 4-man), but by reducing structural weight, tiny tungsten weights can then be ideally placed to achieve a better center of gravity.

Another innovation was the suspension of the crew in a webbing half an inch above the sled floor, and the foaming in of the crew with polyurethane to reduce their bouncing around during the run, thus increasing stability. Airflow also streamlined the articulation ring which connects the front half of the sled to the back half. The ring allows the

PELTONEN SUPRA SKI



The new skating ski styles demand a shorter, stiffer cross-country ski. Peltonen relies on a sophisticated marriage of Nomex honeycomb, wood veneer and synthetics. Skating also demands a longer, stiffer ski pole. The Exel version incorporates an asymmetrical basket which improves pole plant and thrust.

EXEL SKI POLE



GOLD MEDAL GEAR

two pieces to rotate independently. This innovation allows the front of the sled to bank into the turn a split-second sooner than the back half, which promotes a faster, smoother transition around the corners.

To test the performance of steel alloys and geometries for the sleds' runners, ASC constructed a small track inside a refrigerated trailer. Testing up in Calgary, the research team was looking for a harder, more corrosion-resistant alloy to maintain smooth-

ness, and an alloy that is less thermal conductive, since the heat created by friction melts the ice and actually improves speed.

Nordic Skiing

Whether in biathlon, Nordic combined (cross country and ski jumping), or Nordic skiing, the major innovation in cross-country skiing in the past six years has been the dramatic introduction of the "skating" technique, in which the skier kicks the skis outward as though ice skating. The new technique has resulted in changes in ski waxes and in a shorter ski (10 cm shorter) with a stiffer camber, or arch. But the greatest changes have occurred in ski poles. The skating technique demands longer poles (15 cm longer). They reach the eyes now instead of the armpits. Skating also puts more

weight on the poles, causing increased pole deflection and the poles are more apt to be bent by the skis during skating.

Consequently, ski pole manufacturers have been developing poles that are stiffer and stronger, yet remain as light as the earlier, shorter poles. Traditional aluminum poles have given way to poles made of high-modulus carbon fibers, cold-drawn polyethylene, and aluminum/carbon composites.

Other ski pole innovations include an asymmetrical basket that improves pole plant and thrust, and a T-shaped grip that allows the skier to use his hand much like a swimmer does, which enhances poling power.

Hockey

American hockey players will be wearing innovative protective equipment consisting of a triple layer of foam laced with very tiny air cells. The impact of a puck or errant stick forces air out of the cells laterally as the foam collapses. The dense outermost layer collapses only on the hardest hits. The pads will be worn over the shoulders, upper arms, sternum, elbows and in the lower back.

The hockey venue itself offers an intriguing new technology. Teams will play in the Olympic Saddledome, home of Calgary Flames of the National Hockey League. The dome seats 19,428 spectators and features the world's largest concrete suspended roof to allow a pillar-free view from every seat. The precast concrete structure is a saddle-shaped reverse hyperbolic paraboloid and covers three acres.



DONZIS HOCKEY PADDING



Body armor for Olympic hockey battles, the Donzis protection system consists of a lamination of air-impregnated multidensity foams encased in nylon sheathing.

Speed Skating

Because of the extremely tight curves of Calgary's new short-track speed-skating oval, a Canadian skate maker, Raymond Laberge, has developed a skate with a blade offset from center that can be adjusted for each skater. The feature allows the skater to adjust the skate to fit the track. Laberge also custom-molds a skating shell of graphite fiber, Kevlar, fiberglass and epoxy resins.

The form-fitting boot prevents heel slippiness in the turns, which reduces control and power. A Velcro-attached lace cover ensures waterproofing and helps to limit the skate's aerodynamic drag, critical in a game where inches count.

Although no real figure skating innovations are anticipated in Calgary, the U.S. Figure Skating Assn., has an ambitious program underway for the next two Winter Olympics to develop stronger but lighter boots and blades to absorb the tremendous shocks created by increasingly demanding jumps. Leather remains the likely boot material, though molded plastic will be examined. Ceramic blades instead of steel may also be in skating's future.

Indeed, the future is what these and other technological developments are all about. Whatever the outcome on the rinks, runs, slopes or ovals of Calgary, new technologies may emerge to benefit the Olympians of tomorrow.

But for now, don't ever say America can't build a decent bobsled. **PM**

LABERGE MOLDED SKATE

CARBONFIBER/KEVLAR/
FIBERGLASS/EPOXY SOLE

OFF-CENTER
BLADES

KEVLAR-
REINFORCED
UPPER
LACE COVER

PHOTO BY MORRIS LEWIS

Central to the Laberge design is an adjustable asymmetrical blade. Light weight and aerodynamic features mean better adaptability to short tracks.

Straight Shooter

Aiming for gold with a breakthrough gunstock.

IT WAS bone-chilling cold, but I could see sweat on U.S. Biathlon Team members as they raced into the frozen rifle range. Cross-country skiers sprinted in, dropped their poles, hoisted their .22-caliber rifles and 11.5-centimeter targets began to drop 50 meters away. After five shots, they reslung their rifles, picked up their poles and raced off.

These were only practice runs at the West Yellowstone, Montana, biathlon training camp, but the level of skill and intensity demonstrated a newfound confidence by the U.S. team. For the first time, the U.S. is expected to be a match for the dominant Russian and European teams. "We don't feel second-rate anymore," said Sigvart Bjontegaard, head coach of the U.S. team. "I can honestly say we have more talent right now than many of the top-rated teams. It's just a matter of putting it all together on one particular day in Calgary." The reason for the team's soaring optimism is a series of surprisingly high finishes in recent international competition, crowned by Josh Thompson's second-place finish at the 1986 Biathlon World Championships. Thompson's achievement—the first biathlon medal ever won by an American—stunned the biathlon world, and focused attention on the U.S. team's innovative rifle stock.

Two-thirds of the U.S. National Team, which includes Thompson and three other Olympic team members, use a lightweight, skeletal rifle stock developed by biathlon expert Glen Eberle. The deeply cutaway stock, made by laminating together 10 layers of Sitka Spruce and four layers of carbon fiber, is considered a radical departure for the biathlon.

Eberle's stock weighs 1.5 pounds compared to 4.1 pounds for a tradition-

al stock. All wood unnecessary for strength has been removed to maximize a weight advantage that some have calculated to be a second gained in a race for every ounce saved. Despite the weight reduction, the feel of the rifle is comfortable due to the retention of all major components—forestock, cheek piece, pistol grip and butt. Accuracy is maintained by using the West German-made Anschütz 1827 barrel and action, and by shifting its center of gravity forward to give the shooter a sense of a heavy rifle.

Although Eberle's been experimenting with skeletal stocks since 1982, his design attracted little attention until Josh Thompson won a silver medal in 1986. Now, custom-made Eberle stocks are found on the British, Canadian and Swiss national teams. The Austrians copied the design and built



Hotshot Josh Thompson, using a skeletal rifle stock, sets his sights on the U.S.'s first Olympic biathlon medal.

one of their own, and the West Germans mounted a protest to have it declared illegal—a move that failed.

As of now, the biathlon doesn't have the high-profile image in America of many other Olympic sports, but that may be about to change. If the team finally breaks into the medal category this year at Calgary, then the Eberle rifle stock and Josh Thompson, who are "probably more famous in Europe than in the U.S.," according to coach Bjontegaard, will get the recognition they deserve.—Joe Skorupa



Top gun for the U.S. biathlon is the ultralight Eberle stock (above), which uses a deeply cutaway design that has potential applications for hunting (bottom gun).



Country Cupboard

A contemporary version of an Early American cabinet that you can build.

BY NEAL BARRETT

EARLY American furniture makers produced a wealth of designs that reflected the needs and resources of American life. Drawing on a seemingly endless supply of pine, oak and maple, the craftsmen of 200 years ago were known for quality workmanship and common-sense design.

This piece is a fine example of a typical cupboard built in the late 18th century. In the tradition of the American craftsman, we've modified the construction to make use of modern materials. Where wide pine boards were used on the original, we're using stable birch plywood. The trim, door frames and drawers are solid poplar and the upper back is characteristically sheathed with tongue-and-groove boards. And to give the cupboard an



authentic look, we applied a milk-paint finish commonly found on pieces from this period.

Begin by cutting the plywood for the panels, that have edge banding on only one edge, slightly larger in length and width than necessary. Trim these to size after the banding is applied. The upper case top and bottom are cut exactly to length and trimmed to width after banding. Then, cut the upper sides exactly to size. Rip enough $\frac{1}{2} \times \frac{3}{4}$ -in. poplar for all exposed edges and the $\frac{1}{2} \times 2\frac{1}{4}$ -in. piece for the lower case bottom.

Apply glue, clamp the first edge band in place and check that its edges are flush with the plywood. If you don't have enough clamps to space them 4 in. apart, use a caul to ensure even pressure. Let the glue set for at least 30 minutes before removing the clamps and banding the next panel.

Miter the banding for the upper case top and bottom. Tack mitered

Color photo: J.R. Rost
Black-and-white photos: Neal Barrett
Technical art: Eugene Thompson
Photo stylist: Gabe Herrick



1 Place clamps about 4 in. apart when gluing the edge band. Make sure the band edges are flush with the plywood faces.



2 After laying out for the dados, clamp a straight board to the work for guiding the router and the $\frac{3}{4}$ -in.-dia. straight bit.



3 Where dados are stopped, use a sharp chisel to square the rounded ends. This dado houses lower case bottom shelf.

CUPBOARD

scrap pieces at the panel ends to help in aligning the front strip. After the glue has set, remove the scrap pieces and install the end edge bands.

Building the cases

Use your router and edge guide to cut the rabbets in the back edges of the upper case and lower case sides for the backs. Lay out the dados that house the shelves in the upper case sides. Install a $\frac{3}{4}$ -in. straight bit in your router and clamp a straightedge to the work as a guide.

Cut the $\frac{3}{4}$ -in.-thick poplar stock for the lower case bearer rails to width and length. Mark the dados on these pieces and on the lower case sides and shelves. Note that the dados in the bottom case sides, shelves and front

bearer rail stop $\frac{3}{4}$ in. in from the front edge. After cutting the dados, mark the stopped rabbets in the sides that accept the bearer rails and cut these $\frac{1}{2}$ in. deep. Square the ends of the stopped cuts. Cut the notches in the shelves and partitions with a fine-toothed hand saw.

Join the shelves and bearer rails to the partitions with glue and 6d finishing nails. Set each nail and fill. Then, apply glue to the mating surfaces on the case sides and clamp (photo 6).

Cut the poplar stock for the face frame and doors to exact length and width and layout the mortises and tenons. Cut the tenons with a dado blade and use a stop block to ensure consistent tenon length. Then, cut the tenon shoulders with a backsaw.

Next, use the drill press to bore centered $\frac{1}{4}$ -in.-dia. overlapping holes

to remove most of the face-frame mortise waste. A sharp chisel cleans the sides and squares the ends. Glue and clamp the mullion to the rails and, after the glue has set, glue and clamp the stiles in place.

The completed face frame is joined to the upper case sides with two $\frac{1}{4}$ -in.-thick $\times \frac{1}{16}$ -in.-wide splines. Install a $\frac{1}{4}$ -in. slotting cutter in the router and cut a centered slot in each side front edge. Temporarily clamp the upper case shelves and sides together and lay the face frame in position to make sure its edges are flush with the case sides. Then, install a $\frac{1}{4}$ -in. straight bit in the router and carefully place the bit in an upper case side groove. Adjust the edge guide against the outer face and remove the router. Then, cut the corresponding grooves in the face frame.

The splines can be cut from $\frac{1}{4}$ -in. plywood, hardboard or poplar. If you choose poplar, cut short spline sections so the grain is at right angles to the spline length.

Assemble the upper case sides to the shelves with glue and clamp squarely. Rout the stopped rabbets in the top and bottom that accept the tongue-and-groove backboards and square the ends with a sharp chisel. Then, apply glue to the upper case side top ends and nail the top in place. Apply glue to the splines, grooves and upper edge of the face frame and clamp the frame in place. Use 6d finishing nails to attach the top to the



4 Panels that fit in stopped dados are notched on their front edge. Use a fine backsaw or Japanese saw to make this cut.



5 Install the partitions in the dados with glue and 6d finishing nails. Use four nails per joint and make sure the edges are flush.



6 The assembled lower case is clamped until the glue sets. Cauls over each joint maintain even pressure along the joint.



7 Cut tenons for the face frame and doors with a dado blade mounted in table saw. Hand screw clamp acts as stop block.



8 Begin the mortises in the face frame by removing most of the waste on the drill press. Use a sharp chisel to finish mortise.

MATERIALS LIST—COUNTRY CUPBOARD

Key	No.	Size and description (use)
A*	2	$\frac{3}{4}$ x 18 $\frac{1}{2}$ x 29 $\frac{1}{2}$ " birch plywood (side)
B**	1	$\frac{3}{4}$ x 18 $\frac{1}{2}$ x 49" birch plywood (bottom)
C*	2	$\frac{3}{4}$ x 19 $\frac{1}{4}$ x 49" birch plywood (shelf)
D	2	$\frac{3}{4}$ x 3 $\frac{1}{2}$ x 49 $\frac{1}{2}$ " poplar (bearer rail)
E*	3	$\frac{3}{4}$ x 7 x 19 $\frac{1}{2}$ " birch plywood (partition)
F1	1	$\frac{1}{2}$ x 4 x 51" poplar (baseboard)
F2	2	$\frac{1}{2}$ x 4 x 20" poplar (baseboard)
G	1	$\frac{1}{4}$ x 25 $\frac{1}{4}$ x 49 $\frac{1}{2}$ " plywood (back)
H*	2	$\frac{3}{4}$ x 10 $\frac{1}{2}$ x 45 $\frac{1}{2}$ " birch plywood (side)
I*	3	$\frac{3}{4}$ x 9 $\frac{1}{2}$ x 47" birch plywood (shelf)
J	2	$\frac{3}{4}$ x 4 x 45 $\frac{1}{4}$ " poplar (stile)
K	1	$\frac{3}{4}$ x 4 x 41 $\frac{1}{4}$ " poplar (mullion)
L	1	$\frac{3}{4}$ x 4 x 42" poplar (top rail)
M	1	$\frac{3}{4}$ x 2 x 42" poplar (bottom rail)
N*	1	$\frac{3}{4}$ x 12 $\frac{1}{2}$ x 51 $\frac{1}{2}$ " birch plywood (top)
O*	1	$\frac{3}{4}$ x 20 $\frac{1}{4}$ x 51 $\frac{1}{2}$ " birch plywood (bottom)
P	15	$\frac{3}{4}$ x 3 $\frac{1}{2}$ x 46 $\frac{1}{4}$ " beaded fir (back)
Q1	1	$\frac{1}{2}$ x 1 $\frac{1}{2}$ x 49" poplar (frieze)

Q2	2	$\frac{1}{2}$ x $1\frac{1}{4}$ x $11\frac{1}{2}$ " poplar (frieze)
R1	1	$\frac{3}{4}$ x $\frac{3}{4}$ x $50\frac{1}{2}$ " pine (cove)
R2	2	$\frac{3}{4}$ x $\frac{3}{4}$ x $12\frac{1}{2}$ " pine (cove)
S	3	$\frac{3}{4}$ x $\frac{3}{4}$ x 4" poplar (block)
T	2	$\frac{1}{2}$ x $\frac{3}{4}$ x $19\frac{1}{4}$ " poplar (button)
U	2	$\frac{1}{4}$ x $1\frac{11}{16}$ x $45\frac{1}{4}$ " plywood (spline)
V		$\frac{1}{2}$ x $\frac{3}{4}$ " poplar (edge band)
W	1	$\frac{1}{2}$ x $2\frac{1}{4}$ x $48\frac{1}{2}$ " poplar (backer)
X	4	$\frac{3}{4}$ x 4 x $39\frac{1}{2}$ " poplar (stile)
Y	4	$\frac{3}{4}$ x 4 x $10\frac{1}{2}$ " poplar (rail)
Z	2	$\frac{1}{4}$ x $10\frac{1}{2}$ x $32\frac{1}{2}$ " (panel)
AA1	1	1 x $6\frac{7}{16}$ x $15\frac{1}{16}$ " poplar (drawer front)
AA2	2	1 x $6\frac{7}{16}$ x $15\frac{1}{16}$ " poplar (drawer front)
AA3	2	1 x $6\frac{7}{16}$ x $23\frac{1}{16}$ " poplar (drawer front)
BB1	1	$\frac{1}{2}$ x $6\frac{7}{16}$ x $15\frac{1}{16}$ " poplar (drawer back)
BB2	2	$\frac{1}{2}$ x $6\frac{7}{16}$ x $15\frac{1}{16}$ " poplar (drawer back)
BB3	2	$\frac{1}{2}$ x $6\frac{7}{16}$ x $23\frac{1}{16}$ " poplar (drawer back)
CC	10	$\frac{1}{2}$ x $6\frac{7}{16}$ x $18\frac{1}{16}$ " poplar (drawer side)

DD1	1	$\frac{3}{4}$ x 15 $\frac{1}{16}$ x 17 $\frac{1}{16}$ " birch plywood (drawer bottom)
DD2	2	$\frac{3}{4}$ x 15 $\frac{1}{16}$ x 17 $\frac{1}{16}$ " birch plywood (drawer bottom)
DD3	2	$\frac{3}{4}$ x 17 $\frac{1}{16}$ x 23 $\frac{1}{16}$ " birch plywood (drawer bottom)
EE	7	Pull Amerock No. BP-812-WD
FF	4	1 $\frac{1}{2}$ x 2 $\frac{1}{2}$ " brass butt hinge
GG		1 $\frac{1}{4}$ " No. 8 fh screw
HH		1 $\frac{1}{4}$ " No. 10 fh brass screw
II		$\frac{5}{16}$ " No. 4 rh screw
JJ		6d finishing nail
KK		4d finishing nail
LL		1" wire brad

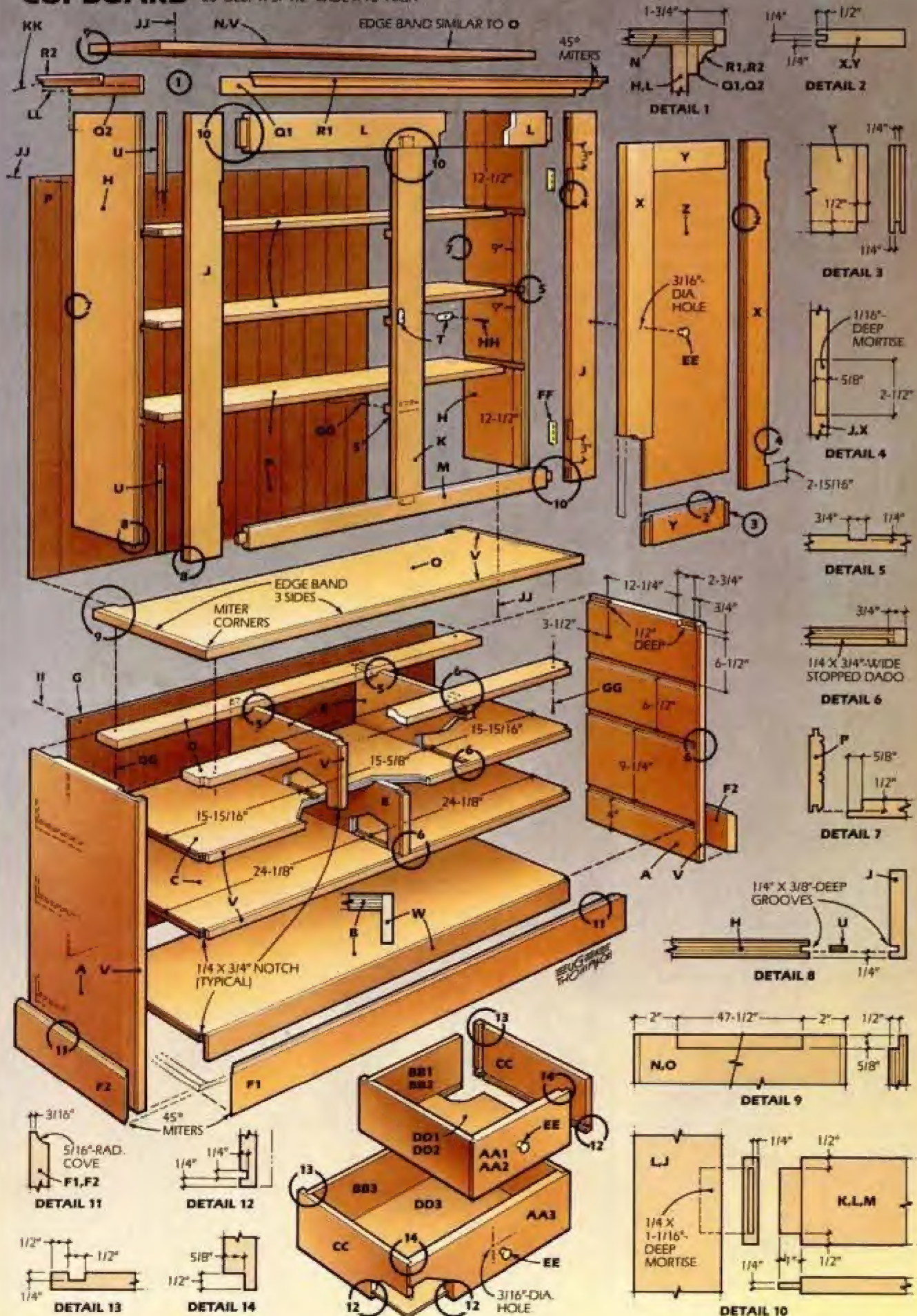
Misc: 120- and 220-grit sandpaper, milk paint available from The Old-Fashioned Milk Paint Co., Box 222, Groton, MA 01450.

* Edge band included.

** Edge band not included.

CUPBOARD

20" DEEP X 51-1/2" WIDE X 78" HIGH



CUPBOARD

face frame. Then, install the shelf support blocks and the case bottom.

Beginning at one side, install beaded tongue-and-groove boards with a 6d finishing nail driven into each shelf as well as the top and bottom.

Rip the 1/2-in.-thick base molding stock to width and cut the profile with your router and 3/16-in.-rad. cove bit. Then, mark and cut the miters and install with 4d finishing nails and glue. Attach the upper case frieze board in the same way and apply 3/4-in. cove molding as shown in the drawing.

Connect the two cases by first boring and countersinking holes for 1 1/4-in. No. 8 fh screws through the bearer rails. Position the upper case, bore

the pilot holes, and install the screws. Cut the plywood back to size and attach with 3/8-in. No. 4 rh screws.

Doors and drawers

Mount your dado blade in the table saw and plow the groove in the door stiles. Cut the panels to size, apply glue to the rail and stile joints, and assemble the doors. Fit each door in the face frame so there's 1/16-in. clearance on all sides. Then, lay out the hinge mortises on the doors and face frame and cut with a chisel. Bore holes for the door pulls and install.

Trim all drawer components to size and use a dado blade to cut the drawer front rabbets, side dados and the grooves for the drawer bottoms. Assemble the drawers with 1-in. brads

and glue. Then, install the pulls.

Carve the turn buttons for the doors and bore and countersink the button screw holes. Prepare for applying the milk paint by sanding the entire cabinet with 120-grit sandpaper followed by 220-grit and dust off.

Milk paint is offered in several colors. We chose Bayberry for this project. Follow the mixing instructions provided with the paint. Wipe the cabinet with a damp cloth to remove any remaining dust and prewet the wood. Apply the first coat with a sponge brush and let dry for at least 4 hours. Then, apply a second coat and let dry overnight. We completed the finish by rubbing down with 4/0 steel wool and applying a coat of Watco Natural Danish oil. **PM**



9 The 3/8-in.-deep spline groove in the face-frame back is cut with the router, edge guide and 1/4-in.-dia. straight bit.



10 After assembling upper case, toenail 3/8-in.-thick beaded tongue-and-groove fir to case back with 6d finishing nails.



11 Door stile groove is cut on table saw with dado blade. This groove houses panel and acts as mortise for rail tenons.



12 Mark hinge locations on doors and cut away waste with sharp chisel. Cut corresponding mortises in face frame.



13 After marking for the mitered ends of the lower case trim, cut to exact length and install with glue and 4d finishing nails.



14 The long front trim piece is installed first. Then, miter the end trim pieces, cut to length and glue and nail in place.



15 The rabbets for the drawer fronts, and other drawer joints, are cut with dado blade. Assemble with glue and 1-in. brads.



16 The two door buttons are hand-carved from solid poplar blanks. Install with 1 1/4-in. No. 10 fh brass screws.



17 Traditional milk-paint finish must be mixed prior to application. Follow instructions and apply with sponge applicator.



OUTDOOR POWER

Here are 11 great pieces of lawn and garden gear.

Dedicated hauling

John Deere's new AMT 600 is a hybrid of several familiar machines. It's part ATV, part tractor and part dump-truck. The AMT acronym stands for All Material Transporter and this machine certainly lives up to its billing. We had the chance to test it for a few months last Fall and during that time hauled countless loads of rocks, bricks, firewood and other heavy cargo up and down steep inclines. We came away thoroughly impressed.

The unit weighs 800 pounds, has an 8.5-hp, single-cylinder, air-cooled engine that runs on regular gas and features: an 11 x 48 x 48-in. dumping



cargo box with a 600-pound capacity, a towing hitch with a 1000-pound capacity, a single front steering wheel with shock absorbers and handlebar controls, and four 25 x 12-9 turf tires on the back. All four rear wheels are driven by means of a variable-speed drive to a transaxle—for the first set of wheels—and a roller chain that joins the second set of wheels to the first. No clutching is required, a differential lock pedal helps the traction in slippery conditions and braking is accom-

plished by two 10-in. rear discs.

One of the great strengths of this machine is its stable, safe ride. With a top end of only 20 mph, a clear choice was made for power over speed. Similar good judgment was used in the control design. A throttle lever on the right handlebar is easily operated by the thumb and the brake lever on the left incorporates a straightforward locking button that acts as a parking brake. The transaxle has three settings—forward, neutral and reverse—all engaged by a single lever on the right, rear wheel well. Remaining controls are keyed ignition switch, choke knob and headlamp switch.

Suggested retail price is a substantial \$3399, but for active consumers with a lot of property—and a lot of work to do—and for commercial operations, this machine could be worth its weight in gold. Beyond the work it can do, however, is a special characteristic: Simply put, it's fun to use.

Our only reservation about the capable, well-made machine was its lack of a hydraulic lift for the cargo box. But Deere now offers this option on new models and has a field-installed kit for older models, available for \$379. For further information, contact Deere & Co., 1400 Third Ave., Moline, IL 61265.



A Woodcutting Wonder

The Jonsered model 535 chain saw is a professionally equipped saw designed especially for firewood cutting. The Swedish-made saw has an excellent power-to-weight ratio for more woodcutting muscle with less fatigue to the

operator. Model 535, complete with a 16-in. bar and chain, weighs only 12 pounds. A 48.6-cc (3-cu.-in.) engine drives the chain 65.6 ft. per second. Other features include an automatic oil pump, chain brake, kickback guard and electronic ignition.

Model 535 with a 16-in. bar costs about \$370. Contact Jonsered, Dept. RPM, Box 68, Rye, NH 03870.

Lawn Warrior

Honda introduces a unique new line of equipment called power carriers. Looking like a cross between a wheelbarrow and a tank, the power carrier is designed to transport rocks, dirt, gravel, bricks, plants and other back-breaking materials over rugged terrain.

Model HP250 (\$1363) is powered by a 2.4-hp engine and it has a carrying capacity of 440 pounds. The model HP400 (\$1868), powered by a 4-hp engine, can carry up to 770 pounds. Contact American Honda, 10866 Wilshire Blvd., Suite 550, Los Angeles, CA 90024.





Tight-Turning Tractor

Looking for the ultimate lawn and garden tractor? Then, check out Honda's new 4-wheel-drive, 4-wheel-steering tractor. The model RT5000

(\$5135) is powered by an 11-hp, 4-stroke, single-cylinder, air-cooled engine that has eight forward speeds and four reverse. Attachments available include a mower, tiller, snowthrower, plow, disc harrow and dozer blade. Contact American Honda, 10866 Wilshire Blvd., Suite 550, Los Angeles, CA 90024.

Lawn Janitor

To clean up leaves, litter and grass clippings quickly, consider Toro's walk-behind lawn vacuum/leaf blower. It's available in a self-propelled (\$739) and push model (\$659). Both are powered by a 5-hp Briggs & Stratton engine.

Use the 30-in.-wide vacuum

and 7-bushel bag to pick up debris on walks, lawns, patios and driveways. An optional 11-ft.-long vacuum hose clears around bushes and trees. The unit also converts to a powerful leaf blower. The airstream can be directed to the front or side. Contact Toro, 8111 Lyndale Ave. South, Minneapolis, MN 55420.



Dirt Buster

For serious gardeners, Snapper offers the model RT5X rear-tine tiller (\$1230). It features a 5-hp engine and 2-way tilling action. Use forward tine rotation for shallow digging and cultivating. Switch to reverse tine rotation to dig deeper, especially in hard soil. The 11½-in.-dia. tines are sharpened on both edges to churn against the pull of the wheels. A 3-position handle swings to either side to keep your footprints out of the freshly tilled soil. Contact Snapper, Box 777, McDonough, GA 30253.



Year-Round Tractor

The new line of Simplicity lawn tractors is engineered to tackle all yard and garden chores including lawn mowing, snow throwing, garden tilling and dirt dozing. The 6500 series of tractors are all 16-hp models that range from \$3280 to \$3870.

All models feature a twin-cylinder Briggs & Stratton engine, disc brakes, electronic ignition and cast-iron cylinder liners for long life. A rugged hydrostatic transmission gives you infinitely variable speed control and large 23 × 10.5 rear tires provide excellent

traction. Wheel weights and chains are also available. All models have a turning radius of just 24 in.

For more information and specific details, contact Simplicity Manufacturing, 500 North Spring St., Port Washington, WI 53074.

High-Performance Mower

Ford's new R-12 riding mower offers a long list of attractive features to help make lawnmowing easier. The mower is powered by an air-cooled, single-cylinder, 12-hp Briggs & Stratton engine. The shift lever controls five forward speeds and one reverse. According to the manufacturer, step-through design makes boarding easier and the rear-mounted engine improves the traction.

It comes with a 30-in. mowing deck that's equipped with special rollers and skids that help reduce scalping. The cutting height is adjustable from 1½ in. to 3½ in. and an optional, rear-mounted grass



catcher holds up to six bushels of the clippings.

The mower can be stood on end for convenient, out-of-the-way storage. The R-12 mower

costs about \$1600. An 8-hp model is also available for about \$1300. Contact Ford, 500 Diller Ave., New Holland, PA 17557.



Mighty Midget



For lightweight woodcutting and trimming, Tanaka offers the model ECS-290 chain saw. The compact saw comes with a 12-in. bar and weighs less than 9 pounds. Features include a 1.8-hp engine, electronic ignition, automatic oil pump and a chain catcher that protects the operator if the saw chain breaks. The take-along saw stows compactly for hunting, camping and other off-road excursions.

The model ECS-290 chain saw is sold at power equipment dealers for about \$220. For more information, write to Tanaka, Marketing Dept., 22121 Crystal Creek Blvd S.E., Bothell, WA 98021.

Bush Barber

Keep your hedges in tiptop shape with this electric hedge trimmer from Black & Decker. Part of B&D's new Lawnforce product line, this heavy-duty trimmer (\$150) features a 24-in.-long bar and a powerful 3.4-amp motor.



According to the manufacturer, the dual-action, ground-tooth blades cut cleaner and faster with reduced vibration. A front-mounted shield and wraparound handle are made to protect your hands during use. Machined-steel gears are used to ensure a smooth-running, long-lasting motor. The trimmer is also available with 16-in. (\$119) and 20-in. (\$135) bars. For details and more information about the Lawnforce power equipment product line, contact Black & Decker, 10 North Park Dr., Box 798, Hunt Valley, MD 21030.

Pass The Leaves Please

Here's a new way to deal with leftovers. Leftover leaves, that is. Feed them to the Leaf Eater—a shredder designed specifically for leaves, grass clippings, twigs and paper.

The Leaf Eater sits on a standard-size trash can and uses flexible lines, like a string trimmer, to shred leaves. The lines can be replaced easily when necessary. Extra cutting line is included. Simply dump leaves into the bushel-sized hopper and it should reduce the equivalent of eight 30-

gallon bags of leaves into just one bag. The Leaf Eater will gobble up wet or dry leaves. The shredding action is adjustable from coarse to fine which makes it convenient for disposal or for use as garden mulch. According to the manufacturer, the Leaf Eater can easily shred 100 bags of leaves in 1 hour.

The Leaf Eater is available in an electric (\$129) or gas-powered (\$229) model. Contact Vornado Products, 2 Main St., Melrose, MA 02176.



SPECIAL REPORT

SPORT UTILITY

**A GOOD-TIME GUIDE TO
GETTING MORE OUT OF YOUR
SPORT/UTILITY VEHICLE**



- THE CASE FOR CUSTOMIZING
- BOLT-ONS AND BEYOND
- NEW GEAR FOR GO: A SUPERMARKET
- BUCK ROGERS BRONCO
- TIRE TAILORING TO SUIT YOUR NEEDS
- GUIDE TO GETTING UNSTUCK

THE CASE FOR



Like most sport/utilities, this S-10 Blazer was designed as a jack-of-all-trades. Customizing sharpens its focus—and rewards of ownership.



AS A CONCEPT, customizing traces its origins to the late '40s and the '50s, when wild was good and outrageous was better. It was an era of anything goes, and most of it went onto the exterior.

Obviously, the world has changed since that era of automotive innocence. Today, we live in an age of sophistication and specialization. Although 4-wheel drive has been around for decades, the notion of sport/utility vehicles as a distinct subspecies is

quite recent, and the boom in that subspecies more recent still.

While there are any number of sport/utility nameplates today that weren't around five years ago, it's rare when one of them matches up exactly to the needs of its owner.

The reason for this is rooted in the laws of mass production. Creating large quantities of a particular item—in this case, vehicles—lowers the cost per item but tends to homogenize the character of that item. The more a manufacturer makes, the less expen-

sive they become—and the more compromises built into each vehicle.

The vehicles rolling off the world's assembly lines today are better than any that have preceded them. We expect more of them—more miles per gallon, more miles between services, more refinements, more of everything—and that's what we get.

Nevertheless, it's impossible for any manufacturer to tailor each vehicle to the individual requirements of each buyer. And that's why the case for customizing is as compelling as

SPORT
UTILITY

CUSTOMIZING

You wouldn't wear a new suit without alterations, would you?

BY TONY SWAN, Automotive Editor



ever—and with more dimension.

The mental baggage we carry from the '50s tends to equate customizing only with the surface of the vehicle, but customizing can obviously apply to a number of vehicle systems—powertrain, suspension, wheels, tires, seating, instrumentation and, yes, cosmetics.

For example, even though one sport/ute may be destined for the desert, another for mud and snow in the Northeast and a third for California freeway profiling, all three may share

exactly the same wheels, tires and suspension componentry at delivery.

Since the original equipment was intended to offer some sort of service in all three environments—and also win the approval of the bean-counters—it can't possibly offer optimum performance in any of them. Obviously, there's room for improvement. By replacing the component intended for general use with one designed for a specific purpose, your ute acquires a sharper definition.

What this means in practical terms

is that you have the power to change your ute from something that does everything pretty well to a vehicle that performs exactly as you want it to.

In the pages that follow, we offer some suggestions for doing just that.

There are expenses associated with this, of course. But the cost-benefit ratio is likely to be positive.

Like the suit you pick off the rack, then refine with tailoring, you'll begin with something you merely like—and end up with something that's truly yours.

PM

The Hardbody,

With the largest cargo volume of any leading standard compact truck, the Hardbody brings new meaning to the term "fill 'er up."

The double-steel wall cargo bed stands up to heavy loads, while the seamless design helps keep it from rusting out.

Large, aircraft-style doors not only make it easier to get in and out of, but also cut down on wind noise.

Just because you beat up your truck doesn't mean it should beat you back. So we've given the Hardbody an extra-roomy, extra-comfortable cab.

Drive a Hardbody and you'll have a lot of pull, thanks to its available 5,000-pound towing capacity.

Nissan® Hardbody SE King Cab® 4x4.
Equipped with Sport and Power Packages,
including standard fuel-injected V6 and
automatic-locking front hubs.

n human terms.

The Hardbody has a greater glass area than the average compact truck. We figure as long as you're sitting up high, you may as well be able to enjoy the view.

With our special Sport Package, you can get the largest factory-available tires on any truck in its class.

The Hardbody has an optional 3.0-liter, fuel-injected V6 that delivers the kind of horsepower it's only human to want.



It's a basic human principle that all men—and women—are created equal.

However, one look at the Hardbody™ will tell you that you can't quite say the same thing about trucks.

Take that sleek, aerodynamic styling, for instance. Not only does it make the Hardbody look better than ordinary trucks, but it actually improves performance.

We were the first import compact truck manufacturer to offer the kind of V6 power it's only human to want.

Speaking of a truck that hauls, the Hardbody also has the largest cargo volume of any leading standard compact truck. Aircraft-style doors keep wind noise to a minimum for a quieter ride.

And by moving the windshield forward, we've even managed to significantly increase the cab's leg, elbow and headroom.

Because being human ourselves, we understand that life is made up of a series of compromises.

We just happen to believe that your truck shouldn't be one of them.



Built for the Human Race.™



See your Nissan Dealer for full specifications of each Hardbody truck model.

**SPORT
UTILITY**

BOLT-ONS AND BEYOND

Building the sport/utility vehicle
that's right for you.

Our concept vehicle has three categories of accessories. Dress-up & Convenience items are something you might find on a ute that's used for urban commuting. Off-Road Gear is for just that—driving away from paved roads to that choice fishing or hunting spot. Rough-Running Gear is for when you are far away from civilization and tow trucks.

DRESS-UP & CONVENIENCE

A custom paint/stripping job, nice alloy wheels and an uprated stereo are traditionally the first things added. Bug screens, sunvisors, step running boards and some sort of interior storage organizers add utility as well.





OFF-ROAD GEAR

Mud-tread, light-truck tires will get you deep into the woods for dawn fishing. Extra lights are a must for looking over the top of underbrush, and gas can and winch are along because the best fishing always seems to be a long way from a gas station.

ROUGH-RUNNING GEAR

When you're really into back-country exploring, away from even a fire road, a brush bar and tubular bumpers will soak up a lot of abuse from rocks and saplings. The skid plate is to keep rocks from eating your oil pan, and the rollover bar is to keep 'em from denting your head.



THE KEY to creating a sport/utility vehicle suited to a specific set of needs is pretty much the same as any project: The success of the result is usually defined by the strength of the planning that goes into it. Although reshaping the basic clay of your box-stock sport/ute is going to entail some expense somewhere along the way, the magnitude of your investment—as well as the pleasure you derive from the finished product—will

be dictated by the clarity of your thinking. The brain, after all, is mightier than the checkbook.

The first step is a hard-eyed assessment of what you hope to achieve and how squarely your dreams mesh with your realities. Be honest. If your sport/utility driving patterns are like most owners', your ute spends most of its time on pavement. Which means that going the full Baja-basher route is likely to net you a vehicle that looks great, but affords all the day-to-day

driving comfort of a cement truck.

In a sense, the sport/utility owner whose custom planning doesn't have to include provisions for dusty trails or muddy bogs has a big advantage: He gets to address the fun part of the project—the exterior—first of all.

However, for our purposes here we're going to assume that you and your ute will be hitting the dirt far more often than the national norms. The general suggestions that follow are designed to help you get the most

out of your mount when you do.

To streamline your browsing, our remarks fall under the three topic areas suggested earlier.

Dress-Up/Convenience

Paint speaks for itself—and for you. Although most utes are available with stripes and rainbow exteriors from the factory—not to mention dealer packages—the surest way to create a truly distinctive look is a paint job.

This is not necessarily as expensive as it sounds. If your vehicle is in good condition, you could get by for as little as \$300 to \$400.

There are only two guidelines:

■ **Stripes:** Try to develop a pattern that's horizontal, rather than vertical or diagonal. Most dings are likely to be horizontal.

■ **Paint:** Acrylic lacquer or urethane are best bets. Colors are bright, and these paints are tough and lend themselves to spot repairs. Metallics and clearcoats are tougher to match.

There's also a wealth of exterior add-ons available—wheel arches,

spats, rocker panel extensions, running boards and even spoilers. One thought: low-mounted spoilers are particularly vulnerable.

Ute interiors have come a long way, but they're still far from the comfort and convenience of an ordinary family sedan. A set of aftermarket bucket seats—from about \$600—will enhance the sense of man-machine partnership, not to mention what they'll do for all-day comfort.

For reel back-road thrashing, you might also want a good set of 4-point belts (from about \$100 per seat).

A sport steering wheel is another dress-up item that enhances your contact with the vehicle (from about \$75), and a CB radio enhances your contact with the outside world.

One other area that can often be improved is instrumentation. A tachometer, and oil pressure and coolant temp gauges ought to be part of the off-roader's array. An oil temperature gauge can also be helpful, plus an amp meter if you're running auxiliary lighting.

Off-Road Gear

When sport/utility owners plan to go where the pavement stops, they commonly bolt on the biggest wheels and tires they can find. This topic is covered elsewhere (see "Rough Rubber," page 104), but a few words are in order here.

While a little more footprint can improve stability by reducing sidewall flex, too much can deteriorate handling and expose sidewalls to damage. Most experts will tell you that one width-size increase is plenty. This also goes for increases in diameter.

Alloy wheels save some weight and come in greater variety, but steel wheels can serve just as well. They're attractive because they bend under severe impact instead of cracking, and can save you a chunk of money.

If ground clearance is the objective, there are any number of lift kits available. However, a little lift goes a long way toward compromising ride, handling and power delivery. Unless you're in real stump-jumping terrain, there's not much benefit.

With extra ground clearance and all-terrain rubber, this Bronco is ready for the rough. Running board improves access.



The easiest and most cost-effective suspension improvement you can make for a vehicle that's going off-roading is a good set of gas shocks (for superior fade resistance). Some manufacturers offer these as optional equipment, but you can do still better. Expect to spend at least \$200 for a set.

Spring replacement, however, is an expensive, time-consuming hassle that's probably unnecessary.

Auxiliary lighting is another must for most sport/utility owners, whether you plan to leave pavement or not. Good lights use replaceable halogen bulbs and throw out plenty of candlepower, so there are really only two guidelines to keep in mind.

First, mount lights high to protect them from various hazards.

Second, pick a brand with a lens secured by screws, to provide better protection for the reflector.

Rough-Running Gear

When you're really off the beaten path, you'll find lots of stuff beating on your ute. And that's when items like brush guards and skid plates come into play. Brush guards protect radiator and/or lights, and shouldn't cost you much more than \$100.

Skid plates fall into the same price category, but are even more important, particularly in the desert. Make sure the plates are steel, preferably 1/4 in. thick, and cover the rear differential as well as the oil pan.

Desert rats or trailer towers will probably also want the protection of oil coolers for their engines and transmissions.

Finally, there's the allure of additional horsepower—difficult and expensive to find these days, but not impossible. One of the easier tricks is an ignition system upgrade—under \$50.

A dual exhaust system can be worth about a 5-percent boost, but the cost is higher—about \$500.

After that you're up against the Clean Air Act and fuel/ignition management, though there are still a couple of possibilities. One is a new intake manifold—there are EPA legal units available, from \$300—that can be worth about 10 to 15 hp.

A more difficult modification is to clean up the exhaust ports, which means time, money (\$400 minimum) and a friendly machine shop, but can net another 5-percent gain in output.

The ultimate horsepower improver, of course, is a turbocharger. Just keep in mind that there's more to this than merely bolting on the blower.

Beyond that, there's only one more thought: Keep the shiny side up. **PM**

NEW GEAR FOR GO



Cobra Stompers

Carroll Shelby's center-lock, knock-off 14 x 8-in. alloy America wheel is the result of a 2-year program designed to produce the ultimate off-road wheel. These knock-off-design wheels can be changed by removing a large diameter center nut, and sliding the wheel off a splined shaft. Thirty-minute installation without replacing stock parts. Set of five costs \$1500. From Carroll Shelby Industries, 19021 S. Figueroa St., Gardena, CA 90247, (800) 421-1269.



Rack & Rail

Suzuki's Samurai is undoubtedly the smallest of the utes. Your friendly neighborhood Suzuki dealer stocks this Rack & Rail module for \$290. Also available are an accessory luggage rack (\$50), ski rack (\$125), bike rack (\$78) and surfboard rack (\$65). If you've got a convertible, the rack, bike, surfboard or whatever can stay in place while the top is down. Skis, too, but then if you're carrying skis, it's probably a little too cold to go topleps.



Max Headroom Liner

Replacing the factory headliner with Highliner's three ABS plastic panels should take no longer than 2 or 3 hours. It's available in several colors, or a natural plastic that's paintable to match your ute's exterior. Highliner provides space to install a radio, CD or cassette player, as well as four speakers, and a panel for mounting gauges just above the driver's line of sight. The kit includes speakers, grilles, wires, antenna cable, all hardware and instructions. \$160 in black, \$180 paintable. From Hoes Corp., P.O. Box 41, Bulverde, TX 78163, (800) 531-5352.

(Please turn to page 113)

SPORT
UTILITY

BUCK ROGERS BRONCO

Ford shapes the next generation of sport/utilities.



AS CONTEMPORARY automotive designs go, sport/utility vehicles can be characterized as anachronistic. While every passenger car in the world pays homage to aerodynamics, utes continue to be as square-cut and straightforward as building blocks. SUV owners *like* them that way.

However, if Ford forecasts prove correct, the shape of utes to come may be more streamlined. A case in point is the Ford DM1, a concept proto currently testing response on the show circuit.

DM1 started out as a senior project competition between 10 students at the Art Center College of Design in Pasadena, California. With tech guidance from Ford, the students made 1/4-scale clay models of the SUV of the 1990s.

The design that emerged on top, by Derek Milsap, so impressed Ford Chairman Donald E. Petersen and design chief Jack Telnaek that they made it into a full-size prototype.

Conversion of the small clay model to show car was handled by Richard Hutting, a California designer who

has worked on a number of Ford projects, including the 1989 T-Bird.

DM1 rides on a humble Ford Escort chassis, but could easily be mated to a 4x4 system such as today's Bronco II. Other refinements: 17-in. wheels with low-profile all-terrain tires, dot-matrix glass overhead with opacity adjustable at the flip of a switch, and a satellite navigation system.

Ford is vague about production plans for the DM1 idea, but creator Milsap is now producing more ideas for Ford—as a member of the truck design group. —Tony Swan



This is the future ute, according to Ford. Though the project began as a styling exercise at Pasadena's famous Art Center College of Design, Ford execs were so taken with the small clay model (far right) that a full-size running prototype was commissioned. Instrumentation (right) is appropriately space age and includes a dash-mounted satellite navigation system. Ford development plans are guarded, but project response was positive.



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Wet Slalom 800 ft. (in seconds)	10.21	10.74
Dry Braking 60-0 mph (in ft.)	190.5	193.9
Wet Braking 40-0 mph (in ft.)	88.01	94.8
Drawbar Pull in sand (lbs. force)	3951	3890
Drawbar Pull in clay (lbs. force)	4766	5016

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GENERAL TIRE



4x4 of the Year.



Jeep Cherokee has just made 4x4 history. For the second time in four years, Jeep Cherokee has been named *4-Wheel & Off-Road* magazine's "4x4 of the Year." It's a feat no other vehicle has ever accomplished. And it's a title that doesn't come easily to anyone.

From an impressive field that included Ford, Chevrolet, and Toyota among others, the magazine chose Jeep Cherokee the best *all-around* 4x4 of the year. And as they explain it, "This isn't domestic versus import. This isn't pickup versus

sport/utility. This is quarter-mile times, horsepower to weight, and day after day of off-road driving."

If any single thing won the day for Jeep, it was Cherokee's optional 4.0 litre 6-cylinder engine. With 177 horsepower and 224 foot-pounds of torque, it's by far the most powerful engine in Cherokee's class. And not surprisingly, we made quick work of winning the quarter-mile acceleration test.

But beyond Cherokee's engine is a lot more that sets this vehicle apart. Like a choice of two or four

doors. A choice of two shift-on-the-fly four-wheel drive systems. And room for five adults.

Go over Cherokee's advantages and it's easy to see why it is *4-Wheel & Off-Road* magazine's "4x4 of the Year" again. Because in Cherokee, we've found the winning combination. The combination you'll find only in a Jeep.

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For further information, call toll-free: 1-800 - JEEP-EAGLE.

Buckle up for safety.

Again.



Cherokee 2-Door



Jeep Cherokee 4-Wheel & Off-Road 4x4 of the Year



SPORT
UTILITY

GETTING UNSTUCK

The most important piece of equipment is mounted between your shoulders.

BY JIM ELDER



HE ONLY off-landers we know who never get stuck are hikers. And even they can get stuck while driving to or from a trailhead. Anyone who ventures off pavement, or adventures in the winter, sooner or later gets stuck. Smaller cars and sport/utility vehicles, plus the emergence of front-wheel drive, have changed some of the rules. The fundamentals are the same, but some of the techniques and tools require a review. Beginning with the best timesaver of all—how to stay unstuck in the first place.

Snow, ice, mud, sand and high centering are the common car stickers. Wet vegetation, slick river rocks and steep boat-launching ramps account for more immobility. Your first line of defense is offense—driving skill and common sense. The second is your



A good self-extraction inventory for backwoods travel should include chains, sand (or sand substitutes), saw, flares and shovel.

equipment and how you use it. Straps and jacks and winches should figure only as the final and infrequently used resort.

Start with your head—and eyes and feet—and perhaps a poking stick. Is that creek really shallow and is the fording area firm—or soft? Should you chain up before trying the mountain pass or after you're sideways in a snowbank? Do the tire tracks on the riverbank indicate that the last boat launcher had to hire a tow truck? Is the beach sand hard, like some Florida, California and Texas beaches, or bottomless, as on the Lake Michigan east shore? Regardless of mechanical refinements, the brain is easier to engage than front-locking hubs.

All potentially sticky situations would be minimized if we could afford different vehicles for specific sports.



Jeep in deep:
When all else fails,
you'll have to winch out.

Soft wide tires for sand, skinny hard tires for mud with a firm bottom, studs or special rubber compounds for ice and aggressive lugs for deep snow. Most of us make do with one all-purpose car, or one car and a sport/utility vehicle of some type. And most of us also make do with the all-purpose wheels and tires supplied by the vehicle's manufacturer.

Snow Belt sportsmen should own and carry a set of chains, even if they live in a state which allows studs or if they use special winter tires. Nothing beats tire chains when the drifts get deep or the ice is slick and steep. The new cable chains are great for radial tires, easy on tire sidewalls, and usable at moderate road speeds. We have yet to test a quick-on chain substitute that's worth carrying. Better to buy a good set of reinforced chains

or cable chains, carry them all winter, and hope you never need them. And when you do, put them on *before* you get stuck—much easier then.

What else does the boondock explorer want to carry? No matter how small the vehicle, a tow rope or strap and a compact shovel should be aboard. If storage space permits, a heavy-duty jack, a come-along, some coarse sand or kitty litter, carpet scraps, and an ax can all be useful. Flares also make sense, not because they'll help you get unstuck but because they let others know you have a problem, as well as where you are.

Are winches worth it? One friend has had a winch for five years and never used it, another would never leave home winchless. Mine is used for many non-emergency tasks, such as dragging out trees for firewood, load-

ing dead cars on flatbed trailers and pulling less prudent drivers from ditches. It is seldom used to unstuck my rig, because I follow a proven 4-wheel fundamental—drive in 2-wheel until stuck, then use 4-wheel-drive to get out and go home. This applies to back-country excursions, of course, not to situations where driving 4x4 is good safety sense, such as on ice or bashing around in the desert or Baja outback.

The proliferation of front-wheel-drive vehicles has unearthed a behavioral quirk not mentioned in the advertising copy. True, front-wheel traction is better on ice, snow and rain-slick roads, on level or moderate-slope surfaces. But steep, uphill climbs can cause an unweighting of the front driving wheels, especially if the vehicle is heavily loaded in the

rear. Our fathers backed up steep hills when the angle exceeded the gasoline gravity-flow system on cars built without fuel pumps. Our sons may find it necessary to use reverse to get out of a steep, slick campsite.

Other don't-get-stuck driving techniques are valid for front, rear or 4-wheel drive. Don't spin. Downshift before you are in a potential spinout situation, but stay in as high a gear or range as possible, to minimize wheel-spin possibilities. Use vehicle momentum whenever it's safe to do so, and plan ahead to avoid brake application in greasy going. Directional changes should never be sharp or sudden. Use any "crowning" or banking to your advantage, even the wrong side of the road if your sightline is clear and there is no oncoming traffic.

Someday, however, somehow, wherever, you will be stuck. No-where, nowhere stuck. Whether you get out or get stuck deeper depends on you.

Start with rocking the rig, in forward and reverse, gently, without spinning the wheels. If that time-honored technique fails, pushing might help—provided you have pushers handy. If you combine pushing and rocking, keep your helpers on the sides of the vehicle for safety's sake. But don't continue with any course of action that's only complicating the problem. Better to start shoveling, put on the chains or go for towing help, before you bury the outfit all the way up to the frame.

Sometimes doing nothing is best, at least temporarily. I once stuck a 4x4 truck on the way in to a remote hunting cabin with some friends late one October evening. The temperature was dropping fast, so we walked on in, made supper, and came back for the truck after our bodies were warm and full and the trail was frozen and firm. It moved right out, as though there had never been a problem.

Wisdom (or inspiration) can be as good as a winch. On another occasion when stuck, we were able to make forward progress but unable to get the right-side front and rear wheels out of a deep roadside ditch. We ran ropes from the rear hitch ball and front spring shackle to trees off to the left. Driving ahead tightened the ropes, and pulled both ends of the rig up on the road.

When I stick my plow, lifting the blade sometimes adds enough weight to the front wheels to give me that extra traction needed to pull out. A friend laced rope around his spoked pickup wheels to substitute for the



Not all episodes begin spectacularly, but the diagnosis is uniform. You are stuck.



Doing nothing—temporarily—can work in slushy goo that will firm at nightfall.



If waiting isn't practical, much can be done with shovel and traction enhancement. Using your winch should be the last resort.

tire chains he had left home. Another used his spare tire and wheel as a jacking pad when the jack kept sinking into a seemingly bottomless mudhole.

We cannot list every getting-unstuck brainstorm here, but the point is to use your head before you walk out and hire a tow truck—particularly when walking out could be a matter of days. And we can review some sense and safety tips concerning more standard tools and techniques. You all know not to get under a vehicle raised by a jack, but don't forget or shortcut just because you are wet/cold/late/mad or all of the above. You should also know that chains, cables and ropes under tension can break and damage anything in the whiplash

path, including people. Nylon ropes and straps are better than steel cables and chains for tugging and towing because they have elasticity. The springy properties of nylon act as a shock absorber, easier on bumpers and hitches, and the rebound effect can help launch the stuck car. Experienced winchers usually use a length of nylon strap in conjunction with the steel cable for these reasons.

Regarding safety, you should be careful of elastic "snatcher" straps, the kind that stretch considerably when you floor the throttle. The idea is to build up some momentum when you're trying to pull with another vehicle. Great idea, but two things to remember: Don't use these when pulling with a winch, because the vehicle will lurch forward, possibly farther than you intended, when it finally comes unglued—potentially straight into the tree you're pulling on. Secondly, be sure that the tow hook or whatever you're pulling on is solidly attached. A crash-resistant bumper is not in this category, and several people have been killed when bumpers pulled loose and catapulted through the windshield of a tow vehicle.

Responsible 4-wheelers and winch-users have also used wide nylon straps to save the same trees that save them a towing bill. A chain or cable, even a rope, can damage or kill a tree. But a 3- or 4-in. web strap will spread the load on the bark. If you must cut branches for traction aids, don't denude roadside greenery, and choose from overgrown or densely vegetated areas. Your emergency forestry might even give more light and water to an otherwise crowded tree, make it an eventual forest showpiece. And don't say you have no time for aesthetics. If you're stuck enough to cut branches, you're not going anywhere soon anyway.

From aesthetics to ethics. It is hard to think friendly when you have shoveled up a sweat to get out of a hole somebody else made, but pretend you are the next guy over that back trail, and fill in any major landscape modification you have perpetrated. If that's too much social responsibility to swallow, take a more practical view and ask yourself if you need to come back out over that same road.

If we all had ¾-ton full-size 4x4s and gas sold for four bits a gallon, we could carry every conceivable aid, equip the rig with special tires and winches and whatever. But cars and sport/utes are smaller and fuel will never again be four bits. We must

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SPORT

drive with more skill, equip and pack more intelligently, and use inspiration and innovation when immobilization strikes. If all else fails, fire up the CB radio, call the auto club and open up a good paperback novel. Help will come. If the CB doesn't reach anyone, don't despair. Help will still come. No matter how remote the location, sooner or later you will be discovered by: 1. a BureauWreck engineer looking for a place to build a dam, 2. a Sierra Club volunteer trying to save your favorite fishing stream from a dam, 3. an insurance salesman, or, most likely of all, 4. the IRS. **PM**



Ultimate test. Step 1: We stuck our Jeep well beyond all powers of self-extraction.



Step 2: In sub-zero cold, we quickly discarded jacks, shovel and kitty litter.



Step 3: With cable anchored to nearby tree (broad nylon-web belt protects trunk), winch and 4-wheel drive had us out, 1-2-3.

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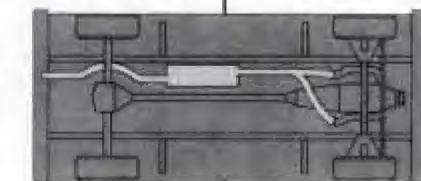
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**SPORT
UTILITY**

ROUGH RUBBER

On road or off, you can't judge traction by the tread pattern.

BY NORMAN MAYERSOHN; Contributing Editor



IT SEEMS they all want the image but, fortunately, few owners of sport/utility vehicles actually take the plunge for that towering, monster-truck stance.

Those who do pay a high price. Radical, oversize tires can impede safe handling because they raise the vehicle's center of gravity. Moreover, they wear unevenly and overstress the driveline. Fact is, except for turning heads on the boulevard, they're no improvement at all.

Still, tire upgrades are the number one change made by vehicle owners of all types, and the temptation to go overboard is especially great with the sport/utility vehicles. Actually, owner surveys reveal that fewer than 5 percent of sport/utility buyers ever take their vehicles off-road.

Yet those folks often insist on buying bold, deep-tread tires for the worst conditions they might encounter, compromising the all-around pleasure and usefulness of their ute.

Yes, you *can* do a lot better than the original equipment rubber when you replace tires, but first you'll need to understand what each replacement design is intended to do.

First, shop for a true Light Truck duty tire—marked LT in the size designation (LT235/75R15, for example), not P as passenger car-rated tires are marked. Most utes come factory-equipped with passenger car tires. LT tires are built with thicker bead sections and deeper treads to meet more severe certification standards. Even when they carry the same load (weight) rating on the sidewall, the LT tires offer about a 10 percent

greater safe load capacity. In a sport/utility filled to the dome light with family and camping gear, that's a comforting margin to have.

In general, high-performance LT radials fall into three tread design classifications: highway rib style, all terrain and mud traction. Some buyers pick the deepest, chunkiest tread pattern on the rack, believing that the most aggressive looking footprint will also give the best traction under all conditions. That's simply not true. What they might end up with instead is a set of tires that not only sacrifice longevity and are maddeningly noisy, but might also provide less traction in some slippery situations.

Though tire manufacturer recom-

Unless you spend Saturday night crushing junk cars, you don't need this much tire.



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recommendations vary widely, General Tire engineer Kevin Geron offered this guide to usage. "Vehicles driven 80 percent of the time on the highway should stick to an all-purpose tire such as our Grabber AP. Sport/utilities that cover 40 percent of their miles off road need an all-terrain tread like the Grabber AT and true mud traction tires should be fitted only when the usage is 70 or 80 percent off-road." Naturally, not every tire builder cites those exact figures, but all agree that a mud traction tire is not the right choice when the vehicle will be used primarily on the highway.

The mud traction tire is just right for campers or fishermen who delve into the backwoods often, though. Several factors are critical to its design. First is a trait known as self-cleaning, attained by an open-tread design that allows the globs of dirt to be thrown out by the force of the spinning tire. But that's not enough. According to Uniroyal/Goodrich engineer Gary Blalock, "Our Mud-Terrain T/A tire uses a laterally oriented tread, with straight void areas across the pattern to achieve better cleat action." That helps the tire dig in.

Traditionally, mud tires are quite noisy, a result of the harmonics set up by the large tread lugs and open areas. Michelin attacked this problem in designing its XC All Terrain by speci-

fying three different pitch lengths for the tread blocks.

Goodyear's just-introduced Wrangler MT goes after the problem with a computer-designed sequencing of the tread lug pitch. This tire is also the first light-truck radial with directional tread design, as pioneered on the Corvette gatorbacks, and must be mounted specifically for the left or right side of the vehicle.

Tread design, rather than size, is most critical to forward motion on gooey surfaces. Goodyear engineer Doug Cassens points out that "wider tires don't always help in mud, because you want to cut down through the loose stuff, not float over it."

The other major drawback of a mud tire is shortened highway life, a result of less rubber actually contacting the asphalt. In the experience of Bridgestone's engineers, you might expect a typical life span of 30 to 40,000 miles from mud tires, compared with 50 to 60,000 for a tire like their Dueler All-Season. Firestone points out that irregular wear can set in as low as 5 to 10,000 miles, so proper alignment and regular inflation pressure checks are mandatory.

The intermediate all-terrain treads have somewhat less of that go-anywhere look, but in fact are a smart choice for sport/utility owners who don't regularly venture off into the

wilderness. As a family, they are characterized by a more closed tread pattern than the mud tires, with tread blocks tied together in larger chunks.

While these design characteristics cut down their ability to self-clean in muddy conditions, it also reduces noise and improves highway steering response and stability.

The big surprise is that all-terrain treads may actually be better in loose-packed snow. Gary Blalock: "Snow traction is a function of the number of biting edges a tire has, and our All-Terrain T/A has more than the Mud-Terrain T/A. This doesn't apply to mud, though, because the All-Terrain tire won't self-clean as well. And we've had the chance to check this many times with our off-road sport/utility racers, like Don Adams."

For some applications, the highway-rib tire is actually the best choice. If 100 percent of your driving is done on paved or hard dirt roads and you live in a region where deep snow is a once-in-a-decade occurrence, there's no reason to suffer with the compromises of tires designed for severe road conditions. You'll get a quieter ride, longer tread life and more handling precision with the rib tires, and since you've upgraded to LT-rated rubber you'll likely have the benefit of increased load capacity.

And there's solid off-road competi-

UNDER THE TREADS

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One of the country's most respected research institutes reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

"Dune Buggies & Hot VWs" magazine April 1983 issue records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work, and that it does reduce engine wear!... for the price of one treatment when compared to engine rebuild, we feel that you'd be money ahead using Slick 50."

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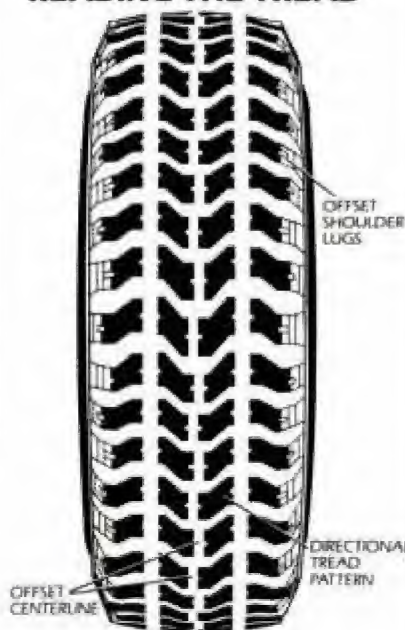
SPORT UTILITY

tion experience to back up your choice, too. On hard-packed dirt courses this is the tread design that works best, and the lightweight dune-buggy classes use them to reduce suspension loads and allow better cornering slides. So they're tough enough to take pounding, even without a deep, gnarly tread pattern.

While the outrageously oversize tires should be reserved for special-purpose demonstration vehicles, you can certainly improve the road performance of your ute with a sane step up in tire dimensions. Full-size domestic models will easily handle this upgrade without wheel-bearing distress. Owners of compact utes should take care not to exceed the largest optional factory tire size for their model. Bridgestone engineer Rick Brennan cautions against altering wheel offset, but also points out that wider rubber can improve highway stability.

Regular tire rotation in the "forward X" pattern (rear tires moved to the front and swapped side for side, provided they're not directional models) will even out wear and lengthen service life. Lowering inflation pres-

READING THE TREAD



Using a unidirectional tread pattern concept developed for Formula One rain tires, the high-tech Goodyear Wrangler MT is designed to be mounted specifically for the left or right side of the vehicle.

ures with truck radials is not a smart plan unless you're stuck in sand. In that case, drop inflation no lower than 20 psi and raise the pressure to manufacturer's recommendation before hitting the pavement.

One bit of advice offered repeatedly by tire engineers is to consult a knowledgeable dealer before making your final choice. He'll know what works best for other customers—and himself—in your region's driving conditions. If he's on the ball he'll ask to see your sport/utility, so he can look for clues like a tow hitch or ski rack and better judge your needs. **PM**

TIRE SOURCES

- Armstrong Tire Co., 500 Sargent Dr., New Haven, CT 06536, (203) 784-2200
- Bridgestone Tire Company of America, 2000 W. 190 St., Torrance, CA 90506, (213) 320-0000
- The Firestone Tire & Rubber Co., 1200 Firestone Pkwy., Akron, OH 44317, (216) 379-7000
- General Tire, 1 General St., Akron, OH 44329, (216) 788-3000
- Goodyear Tire & Rubber Co., 1144 E. Market St., Akron, OH 44316, (216) 786-2121
- Kelly-Springfield Tire Co., Willowbrook Rd., Cumberland, MD 21502, (301) 777-6000
- Michelin Tire Corp., P.O. Box 19001, Greenville, SC 29602, (803) 254-5000
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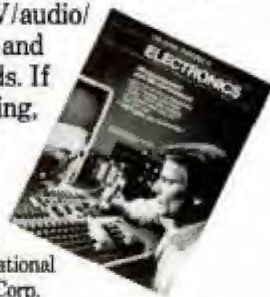
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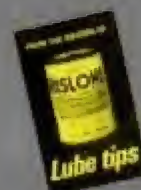
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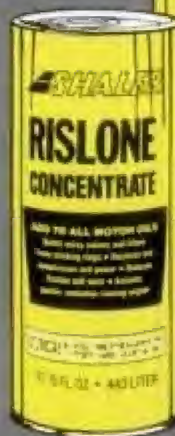
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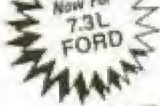
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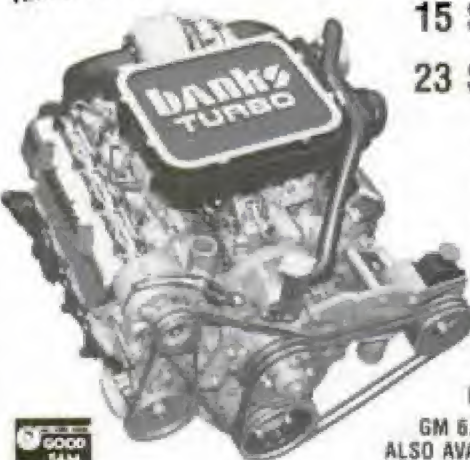
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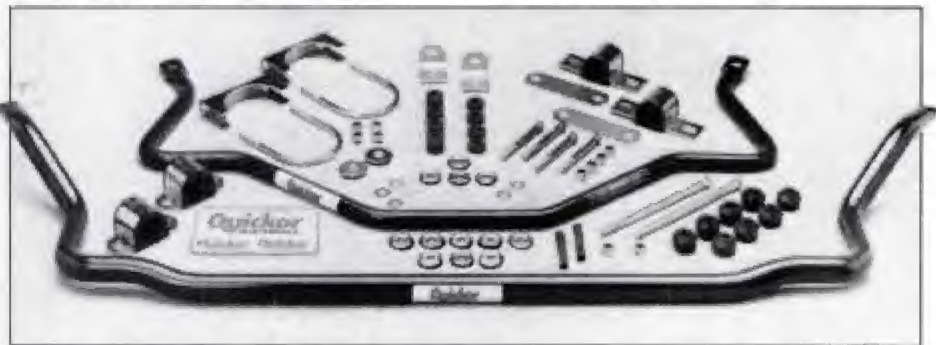
NEW GEAR FOR GO (Continued from page 93)



Truck Tunes

Pioneer understands that trucks in general, and utes in particular, need a rugged, high-power stereo system. With 25 watts of power, and special isolation-mounting for the cassette mechanism, its Truck Rider line also has a Blend control to fade the highs toward the front while leaving the bass

from the rear intact. Stereo Wide separates to compensate for narrow cabs. The knobs and faceplate are armored with rubber to stand up to off-road rigors. Yes, there's an output for your booster amp if you're into keeping the coyotes awake. Cost for the stereos is \$330. Speakers begin at \$150.



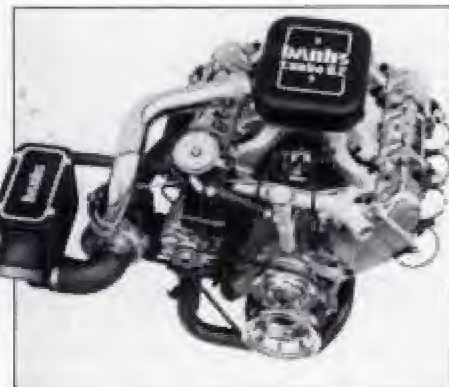
Handle That Ride

Quikcor Performance covers the other end of the handling bench, with a full line of replacement springs, antiway bars, lowering kits and suspension bushing replacements to tune some of the truck out of your ute or pickup. Lowering the ride height or adding antiway bars to your ute won't work out in the woods, but it can substantially improve its handling on smooth pavement. Write for the Handling Handbook, which explains handling theory, and gives guidelines for tuning your suspension. Quikcor Performance, 13270 S.E. Pheasant Ct., Milwaukee, OR 97222.



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(Please turn to page 115)

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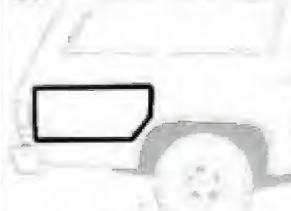
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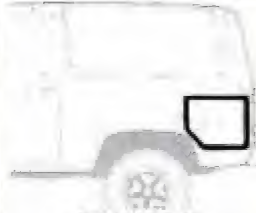
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NEW GEAR (From page 113)



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When you're stuck so badly that even the best front-mounted winches can't find anything to pull on, Warn's Portable Winch, shown here in the 4000-pound model (\$500), can pull your vehicle in any direction. Also handy for places where a vehicle can't go. There's a smaller model with 2000-pound capacity for \$300, as well as a line of conventional bumper-mounted winches. Call Warn at (800) 225-5965, or find them at auto parts stores.



Goodie Box

Even if your winch is proudly bolted to the front of your ute, you'll still need to carry some extra gear along to actually be able to put the winch to work. Warn's accessory kit includes gloves to keep you from pin cushioning your hands on the cable, a snatch block to double your pulling capacity, a nylon recovery strap and a screw-eye clevis for anchoring the cable to big trees. All of this comes in a sturdy plastic box that can live under your back seat until you need it. About \$90 from auto parts and accessory stores, or call Warn at (800) 225-5965.



Gauging It

High-performance boonie-cruising can put a serious strain on the vital parts inside your ute's engine. It can be a long walk home after all the oil has boiled away, so monitor all those important temperatures and pressures. VDO offers easy-to-install electrical and mechanical gauges in both English and metric calibrations. These Cockpit line gauges are 2 1/8 in. dia. with black faces, orange pointers and white characters. The VDO Cockpit gauges are available at auto parts and accessory stores, or you can send \$2 for a catalog to VDO Instruments, 980 Brooke Rd., Winchester, VA 22601, (703) 665-0100.



Give Us A Lift

If you add all the stuff in this section, your ute's bumpers will be dragging. You'll need Air Lift's Polyair Spring which will let you add or subtract spring rate to match the load. Just add or release compressed air at the corner gas station's tire hose. Can be used on front, rear or both ends of vehicles with leaf or coil springs. Kits are available, or they can be professionally installed. Starting at \$71.95, from Air Lift Co., P.O. Box 12150-R3, Lansing, MI 48901, (800) 248-0892.

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LIVING ON THE MOON

(Continued from page 69)

tain various elements. The Moon's crust is 40-percent oxygen (in combination with other elements, of course). This can be isolated. A common mineral on the Moon is ilmenite, or titanium iron oxide. Treatment with hydrogen can cause the oxygen of ilmenite to combine with the hydrogen, forming water, which can be broken up into hydrogen and oxygen.

But where would the hydrogen come from? Those portions of the Moon we have studied are lacking in the vital light elements: hydrogen, carbon and nitrogen. That makes it seem that these "volatiles" will have to be imported from Earth (which has plenty), but there may be places where they can be found in small amounts on the Moon, especially in the polar regions where there are places where the Sun rarely shines. Lunar hydrogen can then be used to obtain oxygen, and lunar nitrogen can be used to dilute it. There you have an atmosphere.

Other elements, particularly iron, aluminum and titanium, all very useful structurally, are common in the lunar crust and can be smelted out of the soil. In addition, silicon can be obtained for making computer chips. The Moon will be an active mining base to begin with. Quantities of lunar soil can be hurled off the Moon by a "mass-driver," powered by an electromagnetic field based on solar energy. This would not be difficult because the Moon is relatively small and has a gravitational pull much weaker than that of Earth. It takes less than 5 percent as much energy to lift a quantity of matter off the Moon than it would to lift the same quantity off the Earth.

To build observatories, laboratories, factories and settlements in space, it would make sense to use lunar materials, especially since Earthly resources are badly needed by our planet's population.

Because of the Moon's feeble gravity, it would be a particularly useful site for the building and launching of space vessels. Since far less power would be required to lift a vessel off the Moon's surface than off the Earth's, less fuel and oxygen would be needed and more weight could be devoted to payload.

Eventually, when space settlements are constructed, they may be even more efficient as places where space vessels can be built and launched, but the Moon will retain certain advantages. First, it will be a world of huge spaces and will not have the claustrophobic aura of the space settlements. Second, a lunar gravity,

though weak, will be constant. On space settlements, a pseudogravitational field based on centrifugal effects may be as intense as Earth's gravitation in places, but will complicate matters by varying considerably with change of position inside the settlement.

Then, too, since the Moon exists and is already constructed, so to speak, it can surely be developed first and be used to experiment with artificial ecologies.

Once the lunar colonists discover how to create a balanced ecology based on a limited number of plant and animal species (which may take awhile) that knowledge can be used to make space settlements viable.

Finally, of course, our Moon, with its enormous supply of materials, may eventually become a self-supporting, inhabited body in the solar system, completely independent of Earth. Surely this will become possible sooner than much smaller settlements elsewhere in space can achieve true independence.

The Moon, as an independent world, will represent a complete new turning in human history. Humanity will have a second world. If Earth should be struck by an unexpected catastrophe from without, say by a cometary strike such as the one that may have possibly wiped out the dinosaurs 65 million years ago—or if humanity's own follies ruin Earth through nuclear war or otherwise—then a second world will exist on which humanity will survive and on which human history, knowledge and culture will be remembered and preserved.

But when will this colonization take place? Naturally, we can't tell because so much of it depends not on technological ability but on unpredictable economic and political factors.

If all goes well, there is no reason why work on the project cannot be initiated in the 1990s. By 2005, the first outpost could be established, and by 2015, a permanently occupied Moon base may be in existence. After that, it may be that the Moon settlers will have developed their world to the point of being independent of Earth by the end of the 21st century.

On the other hand, if affairs on Earth are so mismanaged that there seems no money or effort to spare for space, or if humanity concentrates its efforts on turning space into a military arena and is not concerned with peaceful development or expansion, or if humanity ruins itself forever by means of a nuclear war in the course of the next few decades, then clearly there will be no Moon base, and perhaps no reasonable future of any kind.

PM

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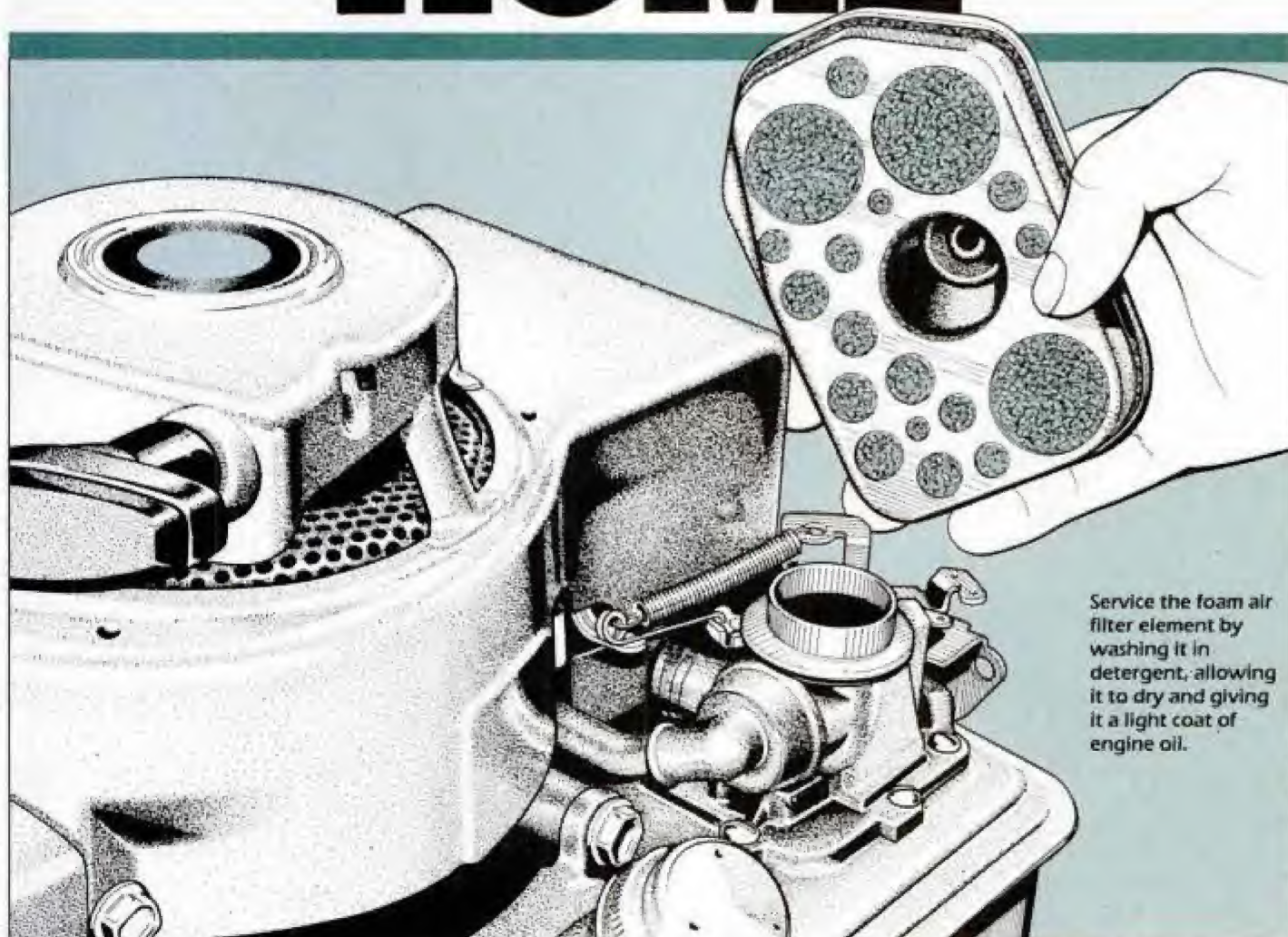


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Service the foam air filter element by washing it in detergent, allowing it to dry and giving it a light coat of engine oil.

How To Overhaul A SMALL ENGINE

BY MORT SCHULTZ; PM Illustrations by George Retseck

IT'S HARD TO believe what owners of small-engine repair shops were telling me—that overhauling those pipsqueak, 1-cylinder, gasoline burners used on self-propelled lawnmowers, snowthrowers and tillers is too difficult for PM readers. To find out for myself, I took a plane to the Briggs & Stratton shops in Milwaukee and spent a day working with Andy Cochrane. This company's well-known products are used in the majority of power implements homeowners are likely to encounter.

After I rolled up my sleeves, it took me just 4 hours to strip down and reassemble the popular B&S 3.5-horse-

power engine. Is the need for special tools a reason for not repairing the engine yourself? Hardly. The fact is, for the work shown here, the tools cost less than \$15, so with just one use they've paid for themselves. I'll point out what these tools are as we go along.

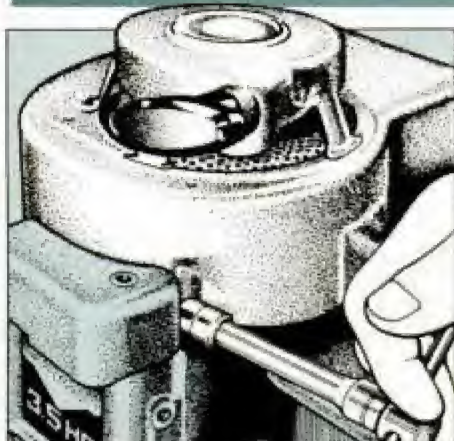
To determine just how far you'll need to tear down your engine, spend the time to troubleshoot its problems. There's no sense going to bare bones just to find out that the carburetor clogged up with fuel deposits after a winter of storage.

Some of our disassembly steps are actually part of a normal maintenance

procedure which Briggs & Stratton calls a *power tuneup*. They point out that a small engine can lose as much as 30 percent of its power after 100 hours of use. Their recommendation is to remove the cylinder head as part of the 100-hour maintenance service. This will let you clean up the head, piston top and valves, removing any buildup of carbon deposits.

Curing other engine ailments requires different degrees of engine teardown. In most cases, refusal to start is caused by ignition or fuel supply gremlins which can be solved without a complete overhaul. Failure to restart after a sudden stop—such as hitting a rock with the lawnmower blade—can often be traced to a sheared flywheel key. This may be remedied by removing no more than the top engine housing and flywheel. If it's an older engine, built before electronic ignition modules, removal of the flywheel is also necessary for replacement of the breaker points.

Rough running, backfiring or a dis-



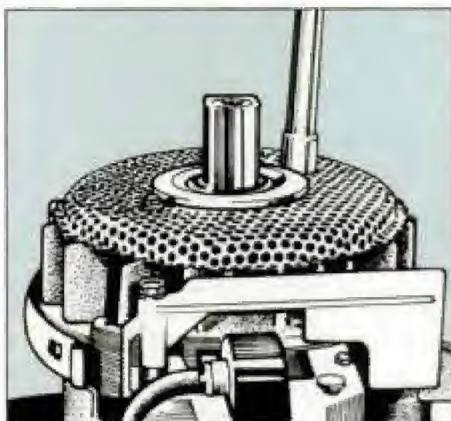
1 Unbolt and remove the top engine cover, which usually contains the pull starter mechanism, for access to the flywheel.

tinct lack of power could indicate deeper problems which will require complete engine disassembly to replace worn piston rings or burned valves. The standard troubleshooting procedures apply here—a compression test, inspection of the sparkplug for oil fouling and checking for a strong ignition spark. As always, the repair manual for your engine model is the best source of instructions, and it will come in handy for valve lash and bolt torque specifications.

Okay, now—here's a step-by-step guide to disassembly and the power tuneup, replete with short cuts:

■ Disconnect and ground the spark-plug cable. Remove the air cleaner, wash the foam filter element in a detergent solution, and allow it to dry. Pour a small amount of clean engine oil over the foam element, squeeze out the excess, and set it aside for reassembly. Drain oil and gas. (It will probably be easier if you unbolt the gas tank from the engine.)

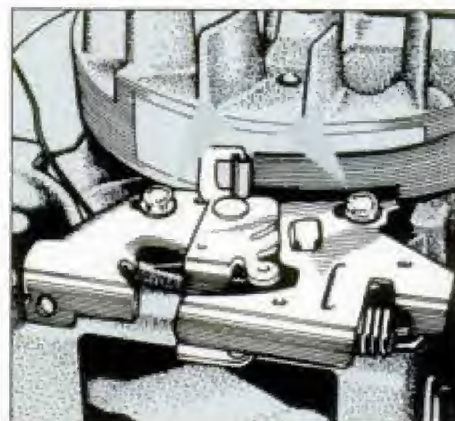
■ Disconnect control cables or linkage, wires and hoses. Unbolt the engine from the lawnmower, snow-thrasher or tiller and place it on your



2 Remove the perforated metal screen on top of the flywheel. Its purpose is to keep large debris from getting inside the engine. Wipe off any dirt or grease, particularly around the sump cover, that could later fall into the engine. Make life easy for yourself by constructing a stand for the engine. A simple cradle built of 2x4 lumber which supports the engine case and lets the crankshaft extension hang free will do fine.

■ Unscrew and remove the blower housing (Fig. 1). Remove the cooling air-intake screen over the flywheel (Fig. 2). Now remove the sparkplug. ■ You are now at the first critical point in the procedure. If you need to replace the ignition points or will be removing the crankshaft, the flywheel has to come off. In order to do that on recent model engines, the brake-band stop has to be released.

The brake-band stop is used to comply with Consumer Product Safety Commission rules for a positive engine-stop that is activated when the operator of the equipment releases the handle. The purpose is to have the engine shut itself off if there's a chance it will be left unattended. The point to remember about the brake-band stop is this: Save yourself the job

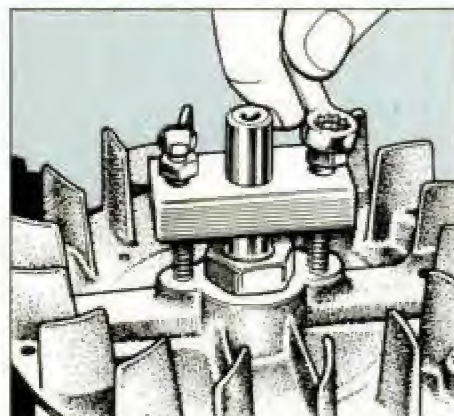


3 Don't touch the two adjustment bolts for the brake-band stop so you won't have to readjust it when the flywheel is back on. of having to readjust the brake band (which requires a special tool) by not loosening its two adjustment screws (Fig. 3). To release the band without upsetting the adjustment, use needle-nose pliers to disconnect the brake spring (Fig. 4). Then bend out the brake lever tang with a bending tool (\$3.50) to free the brake band.

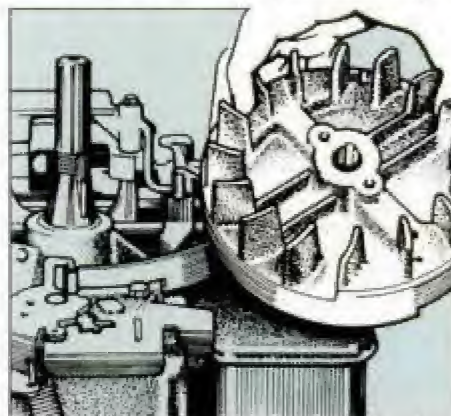
■ Here's what you have to do to remove the flywheel: Put a flywheel holder (cost: \$3.60) in position over the flywheel's fins so the flywheel won't move. Lay a clutch wrench (cost: \$2.60) over the starter clutch (Fig. 5). Attach a breaker bar to the clutch wrench and remove the starter clutch and washer beneath it (Fig. 6).

Important: As you remove each part, identify it with a self-adhering label. I lost 10 minutes searching for a place to put a bolt I couldn't identify.

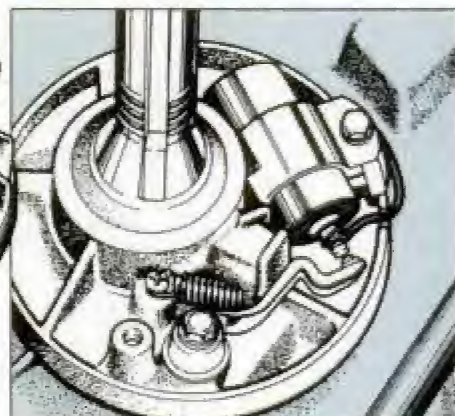
Use an open-end or crescent wrench to loosen the flywheel nut—if there is one—but don't remove it. If there is no flywheel nut, take any nut that is either the same size as the crankshaft threads or is oversize and put it over the crankshaft threads. This is to protect the crankshaft



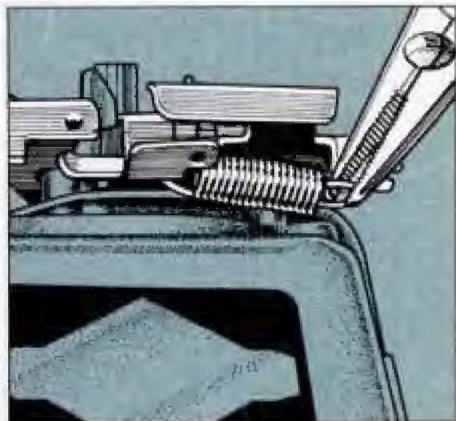
7 Remove the flywheel with a puller, tightening the two bolts alternately to break it loose from the crankshaft.



8 Lift the flywheel off the crankshaft and check the condition of the indexing key which positions it on the crankshaft.



9 Flywheel removal reveals the ignition breaker points on engines built before the changeover to all-electronic systems.



4 Using needle-nose pliers, disconnect the brake-band stop spring. Then bend out lever tang at other end of band.

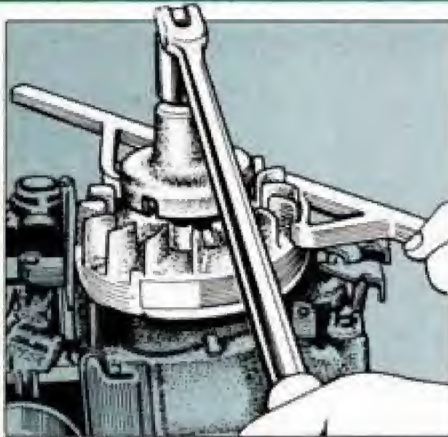
threads as you remove the flywheel.

Locate the two holes on top of the flywheel for the flywheel puller. If this is the first time the flywheel is coming off the engine, those holes may not be threaded. But that's okay. The flywheel puller (cost: \$2.85) has self-tapping screws.

Connect the flywheel puller and tighten each of the bolts and nuts on top of the puller alternately, a little at a time, until the bolts bottom (Fig. 7). You should hear a pop when the flywheel breaks loose. If the flywheel comes loose without a pop, it means it wasn't installed correctly or the inside of the hole where the flywheel fits on the crankshaft is dirty or oily. When you take off the flywheel, clean the hole and shaft, and be sure to retrieve the flywheel key (Fig. 8). Take care not to damage the engine speed governor's plastic air vane.

Caution: Never hit the flywheel with a hammer to loosen it. You will shatter magnets, break flywheel fins or crack the part altogether. You might also damage the crankshaft.

Removal of the flywheel will expose the ignition components of engines



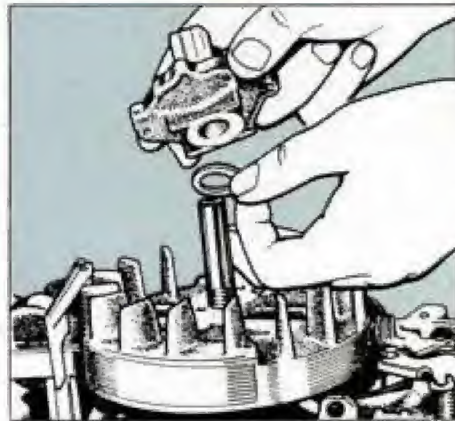
5 Flywheel removal requires a special holding tool to grab the fins and a wrench to remove the starter clutch and washer.

equipped with breaker points (Fig. 9). The condenser should always be replaced with the points. Be sure to apply a thin coat of lubricant on the cam which actuates the breaker points.

■ Remove the cylinder-head bolts (Fig. 10). Then, wiggle the cylinder head until it comes off (Fig. 11). If the head is aluminum, don't pry it off, as this could damage the soft material. If it's cast, prying is okay.

You now have a view of the vital working parts inside the engine. Examine the condition of the cylinder by turning the crankshaft until the piston is at the bottom of the bore. Run your finger up and down the cylinder wall, checking for scratches and scoring (Fig. 12). If the surface is smooth and you don't intend to replace the rings, leave it alone. Should the rings be replaced, though, the glaze deposited on the cylinder wall in normal service must be removed by honing.

More serious damage in the cylinder requires boring out the cylinder to the next oversize and installing a cylinder liner to match. This work is best left to a properly equipped machine shop. Make sure to bring the replace-



6 Once loosened, lift off the starter clutch and washer. Then, loosen the flywheel nut but leave it in place to protect threads.

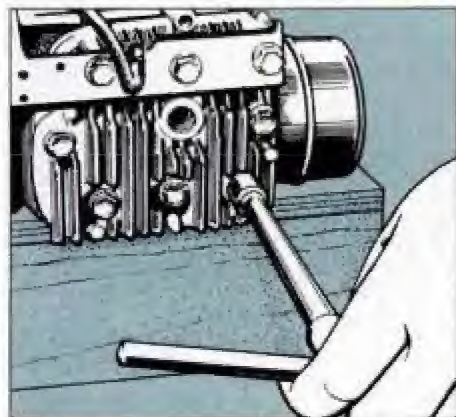
ment piston along when you drop off the engine block.

Inspect the valves—which control intake and exhaust gas flow—for burning or pitting (Fig. 13). This type of damage will ruin the engine's ability to seal compression. Turn the crankshaft to lift each valve off its seat for a thorough looking over. When valves are replaced, it is necessary to seat them with valve lapping compound and measure the lash to ensure that it meets manufacturer's specs as listed in the repair manual.

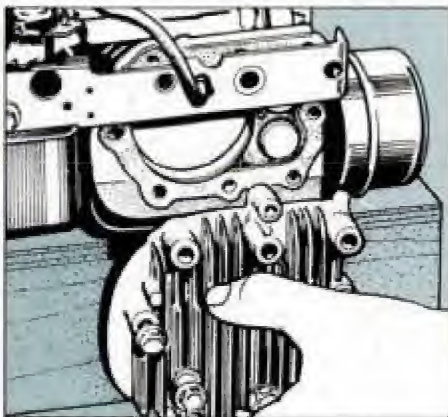
■ Wire brush the cylinder head to get it clean (Fig. 14). With a straight-edge, check the head for warpage on the piston side. If you can slide a .003-in. feeler gauge under the straight-edge anywhere along the gasket mating surface, the head will have to be machined flat or replaced.

Then, turn the crankshaft to bring the piston to top dead center (TDC) and clean the carbon deposits off the piston and valves with a wire brush. This step is the essence of a power tuneup.

■ If your inspections indicate that removal of the piston or crankshaft is



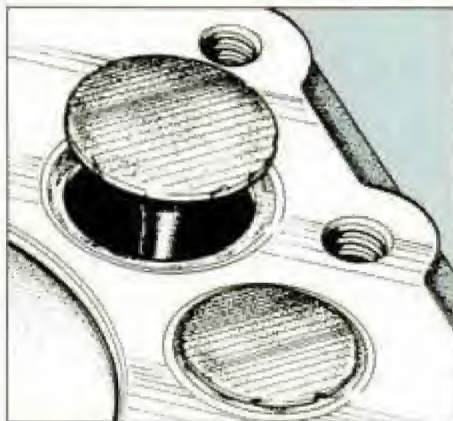
10 When removing the cylinder head bolts, note different length bolts so they can be reinstalled in the proper position.



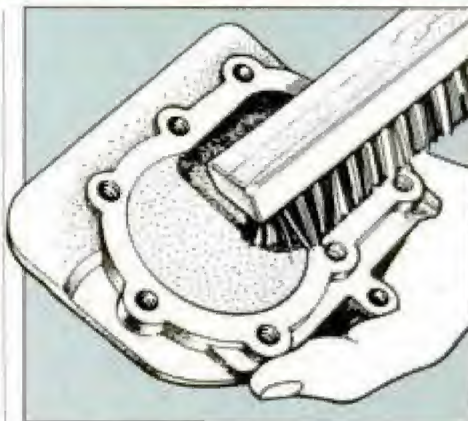
11 Wiggle the head or tap it with a soft mallet to free it from the cylinder, but do not pry against soft aluminum material.



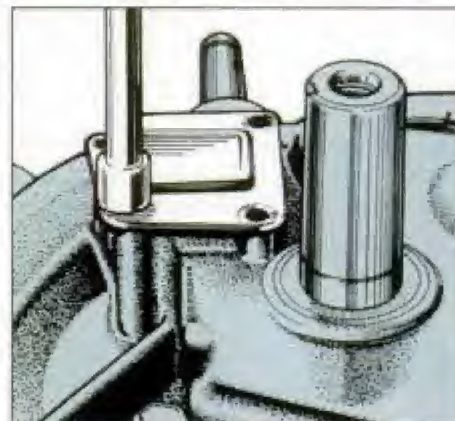
12 Take the piston down to the bottom of its travel and inspect the surface of the cylinder wall for scoring and gouges.



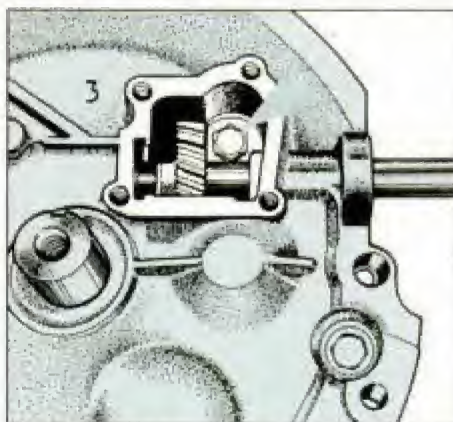
13 Any sign of pitting, burning or material loss around the edge of either valve is grounds for replacement of both.



14 Cleaning the carbon from the cylinder head, piston top and valve area is recommended after 100 hours of operation.



15 Sump cover removal is only possible after unscrewing all six bolts. One may be located under power takeoff gear cover.



16 The sixth bolt retaining the sump cover is concealed on engines with power takeoffs as used in self-propelled equipment.

necessary, the sump cover on the bottom of the engine must be removed at this point, though this is not a normal part of the power tuneup.

Turn the engine over and remove the bolts attaching the sump cover. If the sump cover won't come off and the engine is from a self-propelled implement, look for a hidden bolt under the power takeoff cover (Fig. 15). Unbolt the power takeoff cover and you will find another sump cover bolt inside (Fig. 16). Remove this bolt, then lift off the sump cover carefully (Fig. 17).

By the way, check the length of the "hidden" bolt. You'll discover that it's shorter than the other five—a bit of information you'll find useful when you reassemble the engine.

■ Wipe any accumulated sludge or metal filings out of the engine crankcase (Fig. 18). Before you fiddle around inside the sump, let me point out a couple of things. First, that plastic gear that seems to be just lying in the sump is an oil slinger. Lift it out.

Second, look for timing marks on the crankshaft gear and power takeoff gear. Rotate the shaft until the two



17 Gently lift off the sump cover to prevent damage to the crankshaft, its bearing surface and the oil seal.

marks line up. Now, remove the power takeoff gear and retrieve the thrust washer that's attached to it. This will give you access to the connecting rod cap bolts, tappets and crankshaft for further disassembly. Consult the engine maker's repair manual for these major overhaul procedures on your engine.

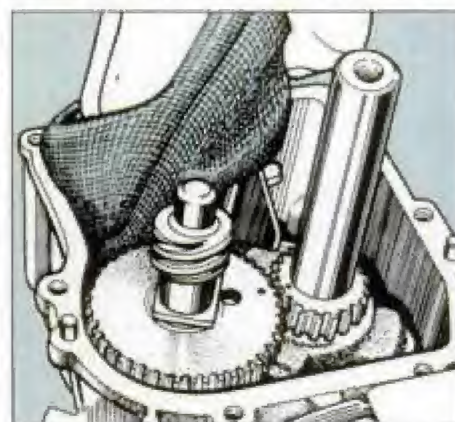
On to reassembly

After finishing the power tuneup, it comes time to put things back together again. I'm not going to sign off just by telling you to do it the reverse of disassembly. You may hit some disaster areas, so here's help:

During reassembly, lubricate all metal-to-metal parts with SAE-20 engine oil, except cylinder head bolts. Give them a shot of high-temperature lubricant such as Never Seize or Lead Plate.

Before you install the sump cover, turn the crankshaft several revolutions to make sure it turns freely without binding. If not, get back inside and find out why it doesn't.

Put a loop of paper around the crankshaft to protect it in case you



18 Wipe the engine sump clean of all grit and sludge before moving on to further disassembly of lower-end components.

accidentally hit against it with the sump cover. Then, carefully lower the cover over the sump.

Don't forget to install a new flywheel key after you install the flywheel. Match slot in flywheel to the slot in the shaft and push in the key.

Get bolt torque specifications from a small-engine parts dealer or by writing the manufacturer. With a torque wrench, tighten all bolts to specification. In the case of this Briggs & Stratton 3.5-horsepower engine, the correct figures are: Flywheel nut, 55 ft.-lb.; cylinder head bolts, 140 in.-lb.; connecting rod cap bolts, 100 in.-lb.

Always install a new head gasket and tighten cylinder head bolts in a crisscross pattern to avoid warping the head. The first time around, tighten them until they just catch. Go back over them and tighten them snugly, then go back and tighten them to the manufacturer's spec. **PM**

For More Information

For a list of special tools for your model engine, request a service tool catalog from the Service Dept., Briggs & Stratton, P.O. Box 702, Milwaukee, WI 53201.

How To Fix A PROBLEM DOOR

BY PAUL BARRETT; PM Illustrations by George Retseck

WHILE most of us think of a house as a static structure—totally unlike a mechanically functioning object such as a car engine, houses do have moving parts. And, in the same way that an engine

needs a periodic tuneup, the moving parts of your house may have fallen out of adjustment and require attention. The doors are the most likely candidates for wear and tear. Changes in humidity cause them to

bind against the jamb, and worn or poorly fit hinges will cause the door to sag. Perhaps it's time to perform a tuneup on your house to get those doors working like new.

Checking the hinges

Hinges should be recessed so the hinge leaves are flush with the door edge and jamb. If a recess is too deep, the door edge can bind against the jamb before the door is completely closed. This condition can eventually loosen the screw fastenings.

Check to make sure the screws are tight by pulling outward slightly on the door. If you see any movement between the hinge and wood, try tightening the screws. If the screw continues to turn when it should be tight, then the screw hole is stripped.

The easiest solution to a stripped screw hole is to replace the old screws with longer ones. Because most jambs are $\frac{3}{4}$ in. thick, installing a $1\frac{1}{2}$ -in.-long screw usually will catch the framing beyond the jamb. First, bore a pilot hole through the jamb for the longer screw. Don't overtighten the new screw to avoid splitting the jamb.

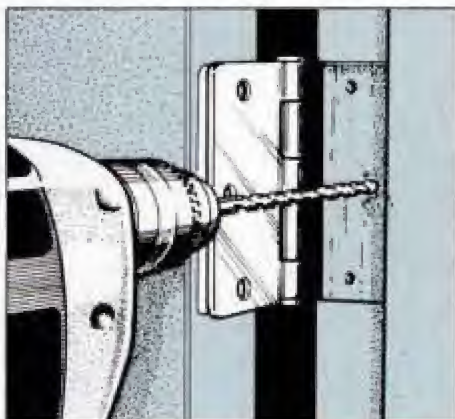
You can also plug a stripped hole with a dowel and then refasten the hinge with the original screw. Begin by removing the hinge leaf. If your door is hung on two hinges, you'll have to remove the door. Check the holding power of each screw so you can fix all the problem holes at once. If your door is hung on three hinges you can remove one of them without removing the door. First, support the door with a couple of wooden shingles or other tapered wedges. Tap these under the door until its weight is removed from the hinge. Then remove the screws to free the hinge leaf.

Using the old hole as a pilot, bore a $\frac{3}{8}$ -in.-dia. hole taking care not to go completely through the jamb. Cut a plug from a $\frac{3}{8}$ -in.-dia. fluted dowel pin. Glue the plug in place and let dry before boring the new pilot hole.

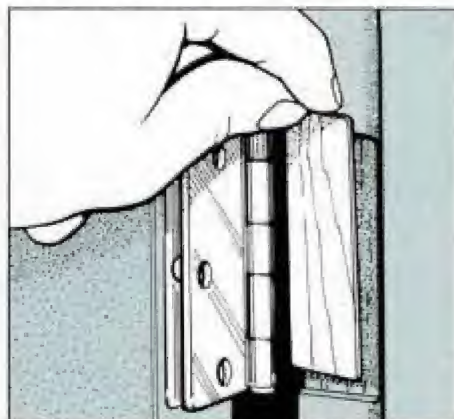
If any of the hinge mortises are too deep, shim them before reinstalling the hinges. Trim a thick piece of veneer or mat board to the size of the mortise. Then, place it in the mortise, bore screw holes and install hinge.



Before removing any of the hinges, place two opposing tapered wooden shingles under the door. Then, take the door weight off the hinges by tapping the shingles together.



1 Fix stripped screw holes by boring a $\frac{3}{8}$ -in.-dia. hole and gluing a plug in place. Don't bore completely through the jamb.



2 If hinge leaf sits below wood surface, the mortise is too deep. Repair by installing shims between leaf and mortise bottom.



3 Use a compass to scribe the $\frac{1}{8}$ - to $\frac{3}{16}$ -in. clearance line on the latch side and top of door. Leave $\frac{3}{16}$ - to $\frac{1}{4}$ -in. gap at bottom.



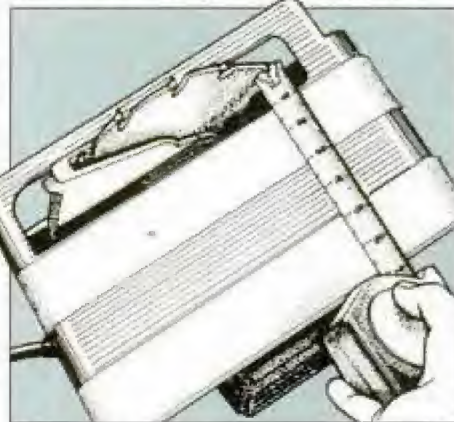
4 A sharp block plane trims door to exact size. Remove door and plane in from ends when trimming top and bottom edges.



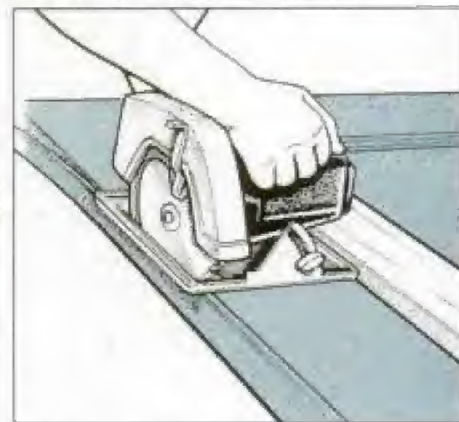
5 First try adjusting the stop clearance by tapping the stop into position. Then, secure the stop with 4d finishing nails.



6 To remove stop, punch bottom nail through and pry the stop off. Pull remaining nails from back with locking pliers.



7 Use a circular saw to remove excessive material. Measure distance from tooth to base edge for positioning cutting guide.



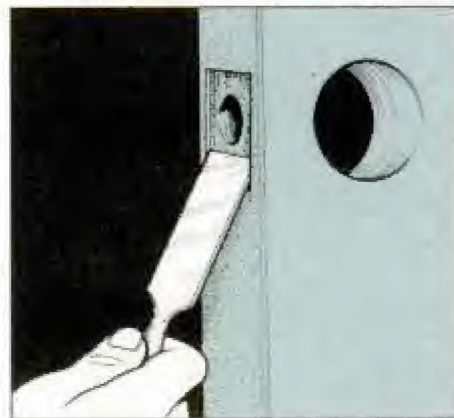
8 Clamp cutting guide to door spaced at the correct distance from trim line. Score line with sharp knife to minimize tearing.

Proper clearance

If the door rubs against the jamb as it closes, it must be trimmed to fit. The top and sides should show a $\frac{1}{8}$ - to $\frac{3}{16}$ -in. space and a $\frac{3}{16}$ - to $\frac{1}{4}$ -in. gap should appear at the bottom. Set an ordinary compass to the correct clearance. Hold the point on the jamb edge and scribe the trim line around the door.

If you have a small amount of material to remove on the latch edge or outer corner of the top, you can do the job with the door in place using a block plane. You may need to remove the latch set. If so, check that the latch plate is flush with the door edge when reinstalled. If necessary, deepen the mortise with a sharp chisel. Trimming the full length of the top or any part of the bottom requires that the door be removed. First, wedge the door to take the load off the hinges. Then, tap the hinge pins out. Remove the top pin last and be prepared to catch the door when it's free.

The top and bottom are trimmed by planing in from each end to avoid splitting the door stiles. If you need to remove more material than can be comfortably planed, use your circular



9 After removing stock near the latch set, check that the plate is still flush with the edge. Adjust the mortise with sharp chisel.

saw for the job. Use a blade designed for making finished cuts and apply masking tape to the saw base plate to prevent marring the door. Then, measure the distance from the plate edge to a tooth on the blade.

Clamp a straight cutting guide to the door so the distance between the guide and the cut line equals the distance between the blade and the base edge. Scribe the trim line with a sharp knife to minimize tear out.

Pulling out the stops

If the door contacts the stops before the latch engages, the stops will need to be adjusted. If the contact area is small, try tapping the stop into position with a block of wood and hammer. Once the door closes easily, nail the stop with 4d finishing nails.

If tapping it doesn't work, or the door is simply too tight all around, remove the stops by punching a nail completely through at one end of each piece with a nail set and then prying each stop off. Reinstall by first closing the door and pressing gently until the lock hits the strike.

With the door at this position, the head stop can be installed with a $\frac{1}{16}$ -in. clearance between the door and the stop. Nail with 4d finishing nails and attach the remaining stops with the same clearance.

In situations where the stop abuts the casing, it's simplest to adjust the clearance by moving the strikeplate. Remove it and expand the latch hole. Then, plug the old screw holes and install the strike in the correct position. Fill the remaining gap with wood filler, sand and finish.

PM

Homeowners' Clinic

BY NORMAN BECKER, P.E.

Crumbling Mortar

I have a masonry chimney venting my oil-fired furnace. The mortar joints up to about 12 in. above the basement floor are beginning to crumble and turn to a white powder. How can I stop it?

S. STEVENSON
CAMDEN, SC

The white powder is called *efflorescence*. It's caused by water passing through the masonry and absorbing soluble salts in the mortar. These salts are then deposited when the moisture evaporates.

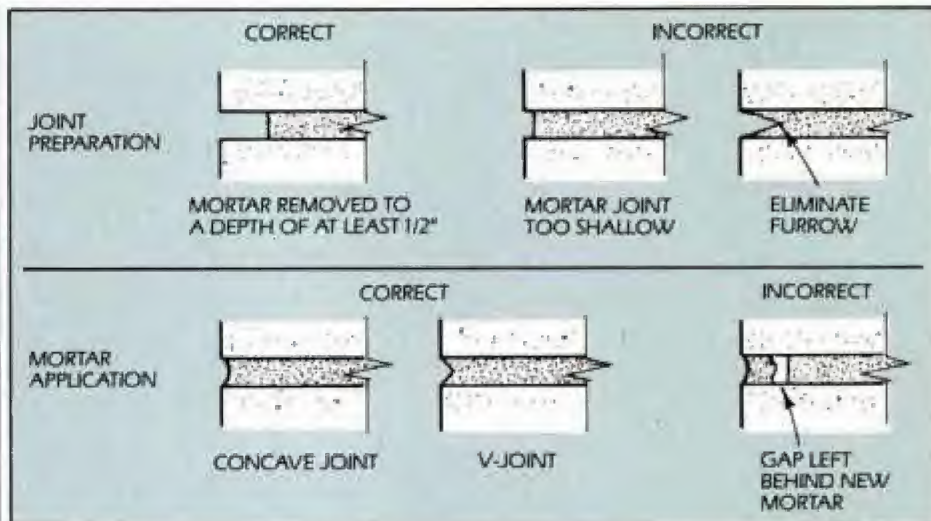
The presence of efflorescence on an older chimney indicates that water is getting inside. It could be coming through cracks in the cement wash on top of the chimney or in the bricks or mortar joints. To stop the efflorescence, you'll need to stop the water from seeping in.

You indicated that the mortar joints are beginning to crumble. When these joints are not in good repair, they permit water to penetrate the masonry. All cracks and deteriorated joints should be repointed. Repointing, sometimes called tuckpointing, is a labor-intensive job. When done with skill and technique, it will improve the water tightness of the chimney, enhance its appearance and extend its life.

The general procedure for repointing is as follows:

Remove the old mortar to a depth of at least 1/2 in. or until sound mortar is reached. You can do this by hand with a chisel or with a power tool such as a tuckpointer's grinder. Unless you have experience repointing, use the grinder for horizontal joints only and clean out the vertical ones with a chisel to avoid damaging the brick. When removing the mortar, avoid creating shallow or furrow-shaped joints as they result in poor repointing. After the defective mortar is removed, clean the joints with a brush or, preferably, spray from a garden hose.

Carefully select the components of the mortar and proportion them correctly. Excessive shrinkage will reduce the mortar bond and make the joint more susceptible to moisture.



To repoint mortar joints, first remove old and deteriorated mortar to a depth of at least 1/2 in. Then, fill with new mortar and tool the joint for water tightness.

For best results, try to duplicate the proportions of the original mortar. However, if in doubt, use prehydrated Type N mortar. Mix one part portland cement, one part Type S hydrated lime and six parts sand, proportioned by volume.

The mortar is generally applied to the cut joint with a tuckpointing trowel. The trowel should be narrower than the joints being filled in order to compact the mortar properly. Firm compaction is necessary to prevent voids and ensure a good bond with the brick and old mortar.

For weather-tight construction, tool all joints to either a concave or "V" shape.

Grease Stain On Wood

Our clear oil-finished natural redwood deck was stained by greasy racoon footprints when the animals disassembled our gas grill one evening. Is there any product or method that will lift the grease out?

J. SHALLBERG
MOLINE, IL

First, try a good washing with a mild detergent and water using a stiff-bristle brush. The stain is probably a mixture of carbon and grease. To prevent a blotchy appearance, wash the entire deck while placing extra effort on the stained area. If that doesn't do it, try washing the area with a solvent such as mineral spirits or paint thin-

ner. Although the solvent will cause the wood to darken when applied, it shouldn't be noticeable after it evaporates. However, as a precaution, it's a good idea to try it on a small non-obvious area beforehand.

If after washing the area a slight stain remains, ignore it and let it weather. Often after a year's exposure to the Sun, rain and snow, this type of stain on a horizontal surface bleaches or washes out naturally. **PM**

Service Tip

The Portland Cement Assn., which is the research, market development and educational arm of the industry, has issued a new edition of the "Cement Mason's Guide." This booklet is fully illustrated and contains instructions for building concrete sidewalks, driveways, patios and steps. It also discusses common surface defects and how to prevent them. The guide costs \$5.95 from the Portland Cement Assn., Dept. DP, 5420 Old Orchard Rd., Skokie, IL 60077. **PM**

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, \$2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

Appliance Clinic

BY STEVE TOTH

Water Mystery

I have a KitchenAid dishwasher, model No. KDS19, serial No. 222149020. Several hours after completing a wash, I find clear water accumulates in the tub and overflows onto the floor. If I press the CANCEL CYCLE button, the water drains out. Sometimes it reappears later. Can you help?

MARGARET CLARO
FISHKILL, NY

Sounds like the water fill valve is causing your problem. Water is probably getting by the valve when it's in the closed position. Then, it collects in the tank and eventually reaches the level of the door where it spills out onto the floor.

Hitting the CANCEL CYCLE pumps the water out only to have the water begin to collect again.

What you need to do is replace the water fill valve. The valve is KitchenAid part No. A-116152 and is available at any KitchenAid or Whirlpool parts distributor in your area. It costs about \$26.

To replace the valve, first disconnect the power and shut off the water supply to the machine.

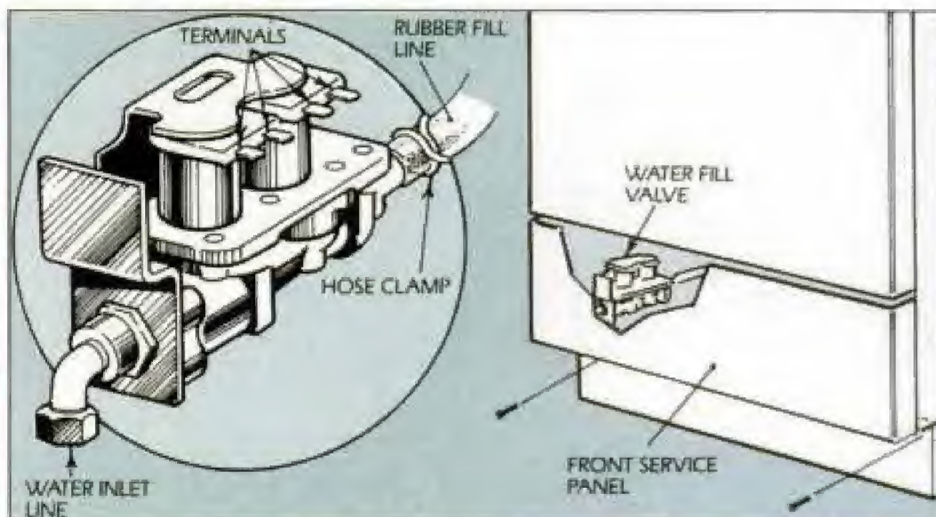
Then, take off the front service panel by removing the two screws at the bottom corners. Push the panel up, then pull forward and down to remove the panel.

Inside, next to the motor, you'll see the water fill valve with the water line attached.

Disconnect the water inlet line from the fill valve. Have a shallow pan on hand to catch the water that escapes from the line and valve.

Next, remove the two screws that hold the valve bracket to the dishwasher frame and disconnect the electrical lead. Then, remove the hose clamp and rubber fill line hose from the valve.

To install the new part, first connect the water supply line to it and turn the water on to check for leaks. If there are none, continue reassembling the dishwasher and give it a trial run. Recheck the water level several hours later to make sure the valve is working properly.



A bad water fill valve can cause water to accumulate in the tub and overflow onto the floor. After removing the front panel, disconnect the old valve and replace it with the new unit.

Fridge Heats Room

The sides of our 16-cu.-ft. Amana refrigerator, model No. ESRFC16C-L, serial No. SF31126215, get almost too hot to touch. When coming into the kitchen, it feels as if the oven is on. A serviceman told us the fridge was working correctly but needed to be disassembled and reinsulated. And, this would cost more than the unit was worth. Can you offer any advice?

LEONARD T. OLOW
MELVINDALE, MI

Your refrigerator has what's called a "hot wall condenser." Spot-welded inside the outer shell is the condenser tubing. There is no condenser fan motor as is found on many units, nor is there a hanging condenser on the back of the fridge. In this type of unit, the heat dissipates through the side walls and top.

Under normal conditions, the sides and top will run 20° to 30° warmer than the room temp. If your kitchen is normally 70° the walls of the fridge could reach 90° to 100° when the compressor is running.

You should have at least 1 in. of clearance between the fridge and any walls or cabinets. Stacking something on top or moving the unit against a wall would prevent normal heat dissipation and add to the heat buildup in the room.

I don't believe reinsulating is a practical alternative. The foam insu-

lation is actually poured in place and sets up rigid when it cures. This bonds the inner and outer skins together and there's no way you can disassemble it.

Needs Cooler Info

We moved to a home equipped with a Whirlpool 3-ton, natural gas, air-conditioner, model No. BTC-1036-5, serial No. S-11930209. This unit is also called an "Absorption Water Chiller." Do you have any information on this air conditioner or know where we can get an owner's manual?

CHARLES NILA
AURORA, IL

Your model air conditioner was built from 1969 to 1971 by the Whirlpool Corp. It's an absorption refrigeration unit that uses ammonia as its cooling medium and is totally unlike conventional systems. Therefore, servicing should only be performed by a specially trained technician with the proper tools for the job.

There is literature still available for this unit. You can get a parts list (LIT-07124) and a service manual (LIT-829221) for about \$5 each from Whirlpool Literature Dept., 1900 Whirlpool Dr., LaPorte, IN 46350.

If you have a problem with any appliance, send your question, with the model and serial numbers to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.



1989 FORD PROBE

Just think of it as the Maztang.

BY MIKE ALLEN, Assistant Auto Editor

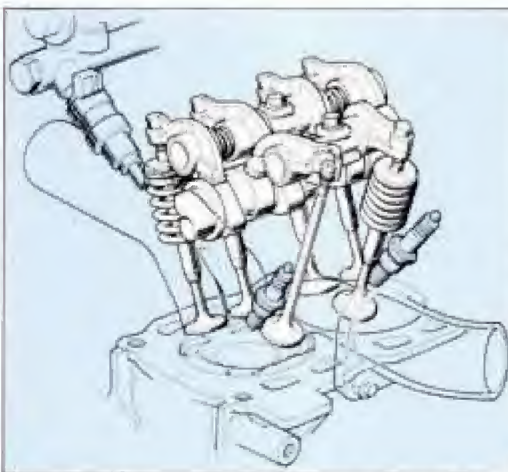
UNTIL NOW, Probe has been the name of Ford's high-tech GTP racing car, as well as a family of concept and show vehicles. The Probe you see here originally was called Mustang IV. Until recently, Ford's game plan was to close the aging Dearborn plant, where rear-drive Mustangs are assembled, drawing on the new Ford/Mazda joint-effort plant in Flat Rock, Michigan, to build a fwd replacement, as well as a similar vehicle carrying a Mazda nameplate.

The current Mustangs, however, are selling well, and probably will remain in production for a good long while. Thus, Ford had to come up with a new name for its new hybrid.

Specific pricing isn't set yet, but Probe is expected to sell in the same neighborhood as Mustang, but Ford perceives its competition coming from the likes of Toyota and Nissan, rather than across the showroom.

Probe shares its running gear with Mazda's 626/MX-6, differing only in spring rates, antiroll bar size, shock valving and bushing compliance.

External body panels are unique to Probe, boasting a C_d of only 0.304 for the GL and LX. The interior design and packaging are well done, and the



Three valves per cylinder give Probe 110 hp, 145 in the intercooled turbo version.

VITAL STATISTICS

ENGINES	SOHC 12-valve, 2.2L/4
	Intercooled Turbo
HP/TORQUE	110 hp, 130 lb.-ft./
	145 hp, 190 lb.-ft.
TRANSMISSIONS	4 Spd. Auto/5 Spd. Manual
SUSPENSION (F/R)	Struts/Struts
BRAKES (F/R)	(GL, LX) Disc/Drum
	(GT) Disc/Drum
TIRES	(GL, LX) P185/70SR14
	(GT) P195/70SR15
STEERING	17.1:1 Variable-assist R&P
WHEELBASE	99 in.
LENGTH/HEIGHT	177 in./51.8 in.
WIDTH	67.9 in./68.5 in. (GT)
TRACK (F/R)	57.3 in./57.7 in.
CURB WEIGHT	2720 pounds

instrument panel is distinctive and practical. The instrument cluster, filled with proper analog gauges, tilts up and down with the steering wheel, adding a nice touch.

With fwd, and a 12-valve 2.2-liter 4-cylinder engine, optional turbo-charging and antilock brakes, the Probe's mechanicals are as good as any in the market segment. And by stiffening the suspension, Ford has made small but significant handling improvements in all three Probe models over their thoroughly capable Mazda counterparts.

Originally, MX-6 and Probe were to share suspension calibration across the board. However, Ford's engineers wanted suspension tuning to be more in line with U.S. tastes, and went their own way. The boulevard ride is good, and high-speed handling on the track (especially the GT) is balanced and solid.

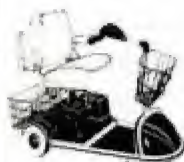
Competent as this car is, though, Ford's suspension tuning hasn't quite made it feel like a Mustang GT. Not yet, anyway.

On the other hand, Ford doesn't want or need another Mustang, just competition for imported Sport/GTs. And given this target, Probe hits the mark.

PM

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REEL VALUE (continued from page 71)



Collectors record when and where they purchase reels and save data-covered boxes. From left: Outdoorsman Castomatic, Pflueger Trump and Shakespeare. All from the 1930s.

original boxes and seek out others who do the same.

Bona fide reel collectors have been on the fishing scene for many years, but only in the past five years have catalogs and books carefully documented the field and helped elevate its status.

One of the most recent sources of old tackle information is *Antique Fishing Reels*, by Steven K. Vernon. This tome, published by Stackpole Books, Harrisburg, Pennsylvania, focuses primarily on multiplying reels. Another valuable book is Carl F. Luckey's *Old Fishing Lures And Tackle*, published by Books Americana, Florence, Alabama. The bulk of this book is concerned with fishing lures, but it is especially noteworthy because it suggests values for reels and lures.

It must be stressed that these prices, and those that appear in other books, are merely guidelines. For example, the top price listed in Luckey's book for a Hendryx fly reel, the large brass model, is \$20. Yet, if you found one in mint condition for less than \$100, most collectors would consider it a bargain.

As with all collectibles, the condition of a reel is an important factor. Also important is availability, or lack thereof. Because reel collecting is relatively new, it's still almost anyone's prerogative to establish a value for an Ocean City trout reel, for instance, or a Pflueger Trump.

There are several dealer catalogs that are valuable research tools. One of the best is published by Martin J. Keane, Stockbridge, Massachusetts. Keane specializes in fly tackle, but also covers saltwater and baitcasting gear.

On the low-end of Keane's spectrum is a South Bend Oreno for \$25. Most collectors would consider this a sleeper, depending on its condition. It's a safe bet that any decent South Bend Oreno will be going for two or three times that figure within five years.

Speculation on the future value of a particular reel is generally little more than personal opinion. Nevertheless, certain trends are becoming clear.

It's a good idea to pay special notice

to fly and baitcasting reels made for specific mail-order houses such as Montgomery Ward, Sears Roebuck, William Mills, L.L. Bean and others. Most of these suppliers never made any reels themselves, but that doesn't mean their products were second-rate.

For example, there are top-notch Meisselbach fly reels to be found bearing the L.L. Bean imprint. These were as good as any single-action reel of their day and are worth at least \$40 in good condition. Some of the William Mills models were made by the renowned House of Hardy in England.

Any baitcasting reel by Meek or Meek and Milam, of Louisville, Kentucky, is a safe bet to increase its value. The more common Meek Bluegrass model is worth as much as \$50. The one marked Meek/Milam, which is made almost entirely out of brass, can fetch as much as \$300. But *caveat emptor!* Some collectors have been stung by counterfeiters who restamp old Meek reels to pass as Meek/Milams.

Practically any reel marked with the Ocean City imprint is a good investment. They're still easy to find for \$5 or less. Even the most complicated Ocean City saltwater models don't go for much more than \$12. All are bargains.

If you're interested in collectibles that you can actually fish with, consider Fin-Nor, Seamaster and Emory fly reels of no more than 20 years ago. The acclaimed Wedding Cake Fin-Nor reel currently changes hands at a minimal \$150, and the Seamaster isn't far behind. Reels made by the late John Emory can fetch upward of \$250.

In the baitcasting department, the old Garcia Ambassadeur 5000s, with reflective red finish, are quickly achieving a coveted status. If you can find one made during the '60s for less than \$20, grab it.

Almost any fly or trolling reel made by Hardy of England before World War II is worth collecting, especially those that run on ball bearings, such as the Perfect model. Of particular interest are Perfects that crank with the left

(Please turn to page 134)



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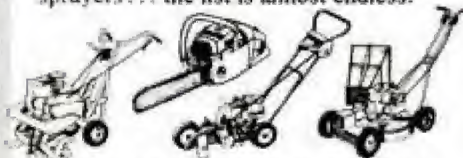
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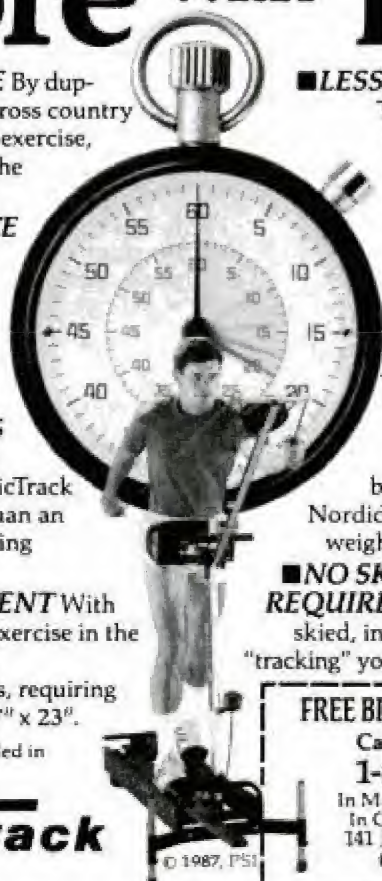
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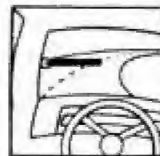
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colored paper with a rich brown ink.
#7453 Country Grocery List Package.....
\$14.55/EA

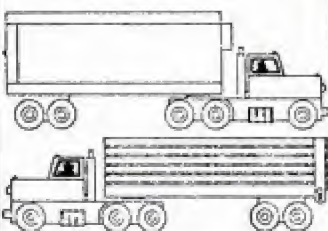
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Build this Doll
Stroller from
3/4" pine and
1/4" plywood.
Extremely easy
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our Huge Plan
Set. Fits 15"
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#W124 Doll
Stroller Plan
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Hardware Kit

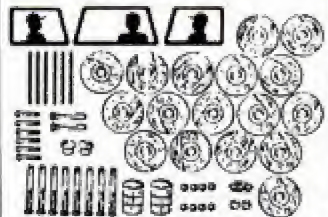
Special Kit includes 4-1/2" stroller
wheels, axles, wood spindles, screws,
wood plugs, and dowel rod. Plan and
other wood parts needed are not
included with kit.
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Build from "2x4" and 3/4" stock. Huge
22" x 34" plans for 2 trucks.
#W144 Truck Plans.....\$4.00/EA

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46 piece kit includes 2" wood wheels,
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lights radiator cap, gas tanks, and
differential cover. Enough hardware
pieces to build one truck from plan
above. Plan and other wood parts
needed are not included with kit.
#1950 Truck Hardware Kit.....\$7.50/EA

Hardwood Toy Wheels



#W675100 3/4".....	\$3.50/100
#W687100 7/8".....	\$4.70/100
#W100100 1".....	\$6.00/100
#W125100 1-1/4".....	\$8.00/100
#W150100 1-1/2".....	\$11.00/100
#W175100 1-3/4".....	\$15.00/100
#W200100 2".....	\$19.50/100
#W22520 2-1/4".....	\$7.30/20
#W25020 2-1/2".....	\$8.80/20
#W27520 2-3/4".....	\$10.20/20

Axle Pegs



#AP1 Fits 1"-2".....	\$4.10/100
#AP4 Fits 2-1/4" - 2-3/4".....	\$1.80/20

2" Wood Wheels With Tread Grooves



#705020 Front.....	\$6.30/20
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(Order #AP4 Peg for above)	
#705120 Dual Rear.....	\$10.50/20
#7051100.....	\$42.90/100
#AP5 Axle Pegs for Dual Rear Wheel.....	\$1.98/20
	\$9.00/100

Birch Shaker Pegs



#7228 3-1/2".....	\$15.00/100
#7280 2-1/2".....	\$1.90/10
#7281 2-1/2".....	\$13.90/100
#7227 1-3/4".....	\$1.10/10
	\$7.60/100

Oak Shaker Pegs



#SKP2 3-1/2".....	\$3.35/10
#7261 1-3/4".....	\$2.00/10
	\$15.00/100

Mug Pegs



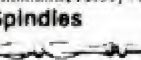
#MGP1 3-3/8".....	\$2.70/10
	\$25.00/100

Birch Country Pegs



#1770 3-1/2".....	\$1.80/10
	\$13.00/100

Birch Spindles



#S6 5-3/4".....	\$4.49/ea
#S85 9".....	\$3.85/ea
#S110 11".....	\$1.35/ea

Birch Dowel Pins



#1142 1/4" x 2".....	\$1.90/100
	\$9.50/500
#1382 3/8" x 2".....	\$2.00/100
	\$9.25/500

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#S1 Birch 1-1/8".....	\$1.30/10
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#S4 Birch 1-1/2".....	\$1.70/10
	\$15.60/100
#S10AK 1-1/8".....	\$1.50/10
	\$12.00/100
#S40AK 1-1/2".....	\$2.40/10
	\$22.00/100

Birch Screw Hole Buttons



#1432 3/8".....	\$1.75/100
	\$7.50/500
#1434 1/2".....	\$1.75/100
	\$8.00/500

Oak Screw Hole Buttons



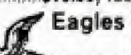
#1452 3/8".....	\$3.70/100
	\$15.50/500
#1454 1/2".....	\$3.80/100
	\$18.00/500

Birch Candle Cups



#7290 1".....	\$2.00/10
	\$13.00/100
#CC1 1-1/2".....	\$2.90/10
	\$19.00/100

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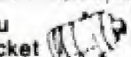
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5-9.....	\$5.10/ea
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#LC4 4".....	\$1.25/ea
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#928 1-1/2".....	\$2.39/10

Screws for Above



#F124.....	\$2.40/100
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Production Screws



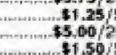
#S277 1-1/4" x #6.....	\$1.70/100
#S278 1-5/8" x #6.....	\$1.90/100
#S279 2" x #6.....	\$2.50/100
#S282 3" x #8.....	\$4.75/100

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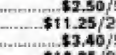
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	\$2.50/25
#7161 3/16".....	\$9.00/5
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	\$6.50/25

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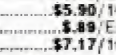
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	\$7.50/25
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Each string is
approximately 36"
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you want to build.
#7288 Door Harp Music Wire.....\$3.55/EA
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Door Harp Tuning Pins



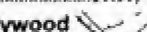
Nickel plated, approximately 1-3/4"
long. Threaded end can be turned into
3/16" hole.
#7291 Door Harp Tuning Pins.....\$3.55/EA
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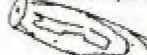
#1342 3/4" Dia. Wood Ball.....	\$1.30/10
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1/8" x 12" x 18" plywood, use for Front
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2-9 Sheets.....\$2.40/Sheet
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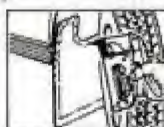
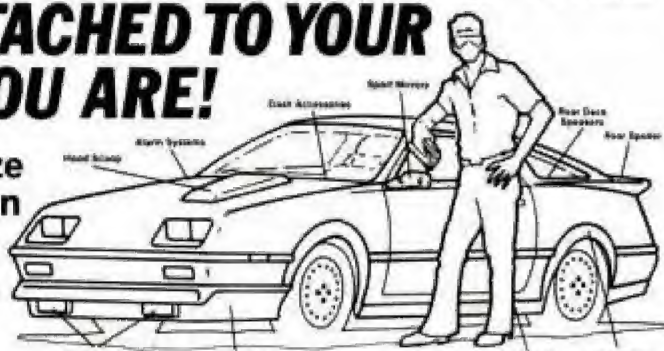
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T-50XP
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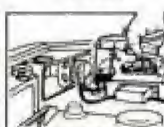
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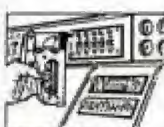
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tool for attaching all
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Simply drill pilot hole, insert fastener,
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it's in and securely fastened.

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REEL VALUE

(Continued from page 130)

hand. They're really worth \$100 or more, but bargains in the \$40 range turn up frequently.

For fishermen who are nostalgic patriots, the collecting of reels is especially gratifying. While it's true that the British were making fly reels before we were, the development of gear-driven, plug-casting reels was largely an American enterprise. The same holds true for offshore reels. Today, the quality reels of Penn and Fin-Nor stand at the forefront of the industry, just as in days gone by, no one made them better than J.A. Cox or Vom Hofe.

In the fly-fishing arena, the old Pflueger Medalist, which is now made overseas, set the standard of quality at a fair price. It is surely destined to grow in collector value. Reels made today by Stanley Bogdan, of Nashua, New Hampshire, command the handsome retail price of \$500. Used Bogdans can fetch nearly as much. Ditto for Ross Reels and the now discontinued Walkers. All of these will soon become important collector items.

The pursuit of large saltwater fish with fly tackle is another area where American technology led the way. Collectible reels, both old and new, are made by Fin-Nor, Seamaster, Emory, Billy Pate, Fenwick World Class, Taurus, Catina and a number of specialty companies. Buying one of these reels today at retail prices is a worthwhile investment to consider.

Time to go out on a limb. Remember those inexpensive reels made in the U.S. out of hard rubber and a material called Bakelite? Reels of this type go all the way back to the '40s and can still be picked up for \$5 or less. My guess is that these once-bargain reels are more scarce than most collectors think.

The Weber Co., of Stevens Point, Wisconsin, made several hard-rubber models, including the Weberkraft and the Futurist. The defunct company Horrocks-Ibbotson, of Utica, New York, made a series of Bakelite reels, including a model called the Vernley.

These reels were light, worked well, didn't rust and sold for low prices. The problem was they cracked if dropped on a concrete floor. Because of this, fewer survive today than collectors believe, and their value is destined to catapult.

By the way, if you happen to come across a Weber Futurist with this writer's initials cut into the spool side, please get in touch. It fell off a car roof somewhere between Roscoe, New York, and Scranton, Pennsylvania. That particular reel will fetch \$600, at least from this writer. But no fakes please, memories of that reel are as clear today as they were in 1948. **PM**

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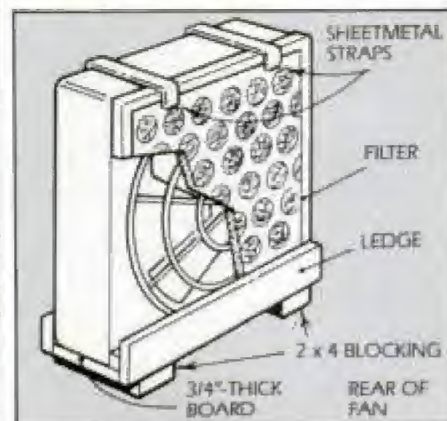
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HINTS FROM READERS

Clean-Air Fan



Floor fans are great for circulating the air. They do, however, pick up and circulate dust as well. A simple solution to this problem is to mount a filter of the kind used in forced-air furnaces on the back of the fan. A 20 × 20-in. filter fit perfectly on our fan. I blocked up the unit and added a ledge to hold the filter bottom as shown in the drawing. Then I bent two pieces of 1-in.-wide sheetmetal to serve as clamps for the filter top.

—Marion S. Roberts

Holddown Clamp

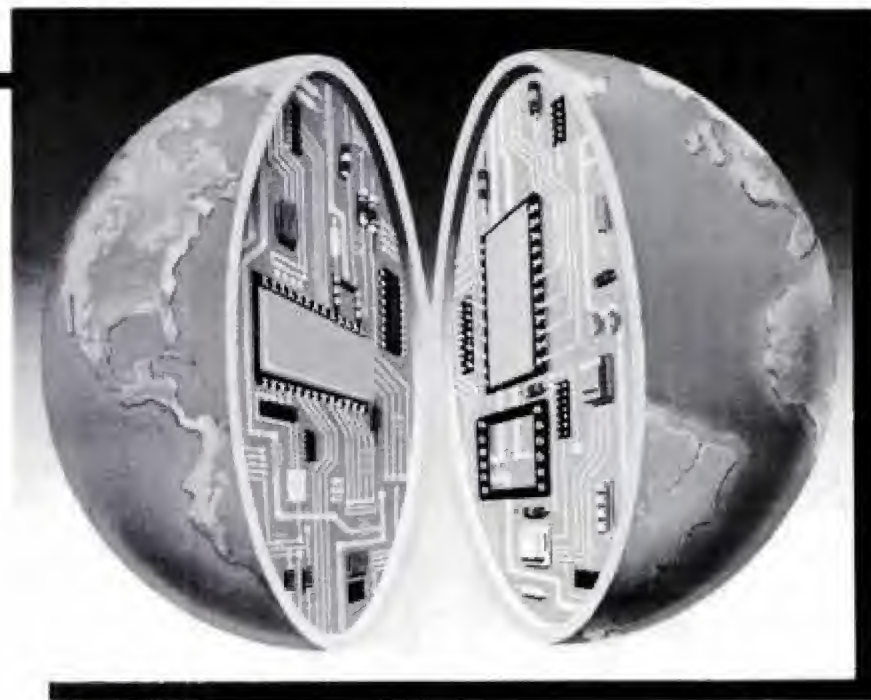
These days, most do-it-yourselfers use a portable Workmate to serve as everything from saw horse to clamping jig. I discovered a way to increase its usefulness with a couple lengths of light chain and two steel rods. If you need to hold some irregularly shaped object to the Workmate surface, simply pass the chains through the tabletop holes on either side and over your work. Then, slip the rods through the chain links under the table. When you open the jaws, the chains firmly clamp your object to the top.

—F.L. Seager

Wheelchair Handles

Pushing my friend in her wheelchair to go shopping gave me a backache because the handles were so low. I solved the problem by extending the height of the handles with pieces of PVC pipe. To give my invention a finished look and match the rest of the chair, I wrapped the pipe with silver-colored duct tape.

—Edna G. Kunze



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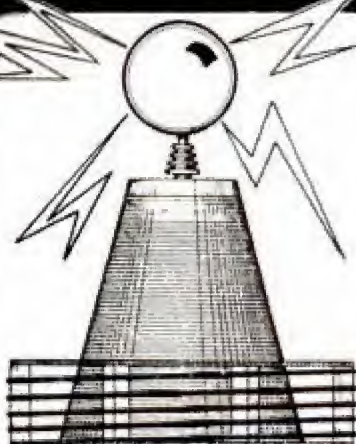
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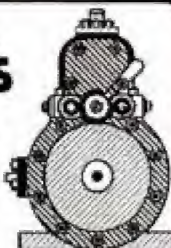
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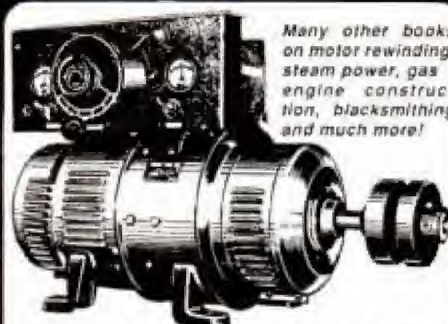
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WORKBENCH BASICS

BY ROSARIO CAPOTOSTO

Respirators To The Rescue

YOU DON'T have to visit an industrial chemical plant to be concerned about inhaling toxic fumes and vapors. Most do-it-yourselfers need only to go into the workshop to face a contaminated atmosphere. Working with certain paints, finishes, solvents, acids, resins and pesticides can produce unsafe and, in some cases, deadly conditions.

To protect your respiratory system against harmful fumes and vapors, wear a cartridge-type respirator. The respirator consists of a rubber face mask fitted with two interchangeable cartridges and filters. There are a wide variety of cartridges available and each one is designed to filter out specific contaminants.

It's very important to install the appropriate cartridges for each specific atmosphere. Remember, no



A dual-cartridge respirator offers valuable protection from airborne dust, mist and vapors. Keep the work area well-ventilated, too. A single cartridge can filter out all contaminants.

Here's a list of some of the contaminants that can be filtered out with a cartridge-type respirator: dust, organic vapors, pesticides, ammonia, chlorine, asbestos, hydrogen chloride, sulfur di-

oxide, paint, lacquer and enamel mist.

An obvious omission from this list is methylene chloride which is found in most paint strippers. No cartridge can filter out this highly toxic chemical. The best protection from methylene chloride

is an air-supplied respirator (see "Paint Strippers: Beware The Hidden Hazard," page 65, Oct. '83).

When shopping for a respirator, be sure that it's NIOSH (National Institute for Occupational Safety and Health) approved. This indicates that it meets government standards.

For a respirator to offer optimum protection, it must fit tightly to your face. Adjust the headbands for a comfortable, snug fit. A beard or long sideburns will interfere with a proper fit. To verify a good fit, hold your palm over the valve cover, as shown, and exhale gently. No air should leak from around the respirator. If necessary, readjust the headbands.

For more information contact Eastco Industrial Safety Corp., 130 W. 10th St., Huntington Station, NY 11746. Or, call toll-free (800) 221-0224.

PM



Install the appropriate cartridges for a specific contaminant. Note that respirator houses a dust filter and an air-purifying cartridge.



Here the cartridges are removed and just the filters are installed. The filters provide protection from dust only, not harmful vapors.



Make a positive pressure test to ensure a snug fit. Hold palm against valve and exhale. No air should leak from around respirator.



Check respirator fittings for dust buildup. Dust accumulation, shown around the valve, allows contaminated air to enter face mask.



Inspect respirator periodically for signs of wear or damage. Any respirator that's dried out and cracked, as shown, should be discarded.



Store respirator in a tightly sealed plastic bag and keep it in a dry, cool place. Direct sunlight will promote rapid deterioration.



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P.O. Box 36930, Cleveland, Ohio 44136

Blizzard-Busting Snowthrower



WITH every winter we must think about snow removal—ugh! To help make this back-breaking chore easier, Toro has introduced a new line of snowthrowers that can handle even heavy, hard-packed snow. Called Power Shift snowthrowers, these 2-stage machines have a steel auger that feeds snow into a high-speed impeller which can throw snow up to 40 ft.

The name, Power Shift, refers to a unique feature that, at a throw of a lever,

shifts the wheels back (rearward) from their normal position. Repositioning the wheels improves traction and, according to Toro, adds an extra 55 to 65 pounds of downward force on the auger. Power Shift snowthrowers come in four sizes: Model No. 624 (\$1050) has a 6-hp Tecumseh engine and clears a 24-in.-wide swath; model No. 824 (\$1180), 8-hp Tecumseh/24 in. wide; model No. 828 (\$1300), 8-hp Briggs & Stratton engine/28 in. wide; model No. 1132 (\$1560), 11-hp Briggs & Stratton/32 in. wide. For more information, contact Toro, 8111 Lyndale Ave. S., Minneapolis, MN 55420.

Toasty Table

The Unique Heat end table provides a clever and attractive way to heat a cold, drafty room. The contemporary-style table has an electric space heater built into its base. Use the table to warm up cold, isolated rooms without activating your home's entire heating system.

The table is fitted with a 1500-watt, thermostatically controlled, forced-air heater and a 103-cfm fan. It's UL listed and it has a heat output of 5119 BTUs per hour.

The table measures 19 in. high x 20 in. wide x 23 in. deep and comes in prefinished solid oak or covered with plastic laminate. Choose from a wide variety of laminates including wood-grain patterns and solid colors. The solid-oak table costs about \$160 and the plastic laminate model costs about \$140. They're sold at major department stores. A matching end table, without the built-in



heater, is also available.

Contact C&S Products, 1085 14th St., Suite 1049, Boulder, CO 80302.

Closing The Foundation Gap

Home construction practices have improved greatly in recent years in regard to ener-

gy efficiency. However, standard homebuilding techniques don't always do an ad-

equate job of sealing the gap between the sill plate and the top of the foundation wall.

Now there's a better way to stop air infiltration at the sill and cut heating and cooling costs. Sill Seal by Dow Chemical is a gasket made of polyethylene foam that is stapled to the bottom of the sill to form a tight, gap-filling seal between the foundation and sill plate.

Sill Seal is 1/4 in. thick and it comes in 50-ft.-long rolls in three widths: 3 1/2 (\$4.85), 5 1/2 (\$6) and 7 1/2 in. (\$8). Contact Inquiry & Distribution Services, 1703 S. Saginaw Rd., Midland, MI 48674.



Morning Warmup



Here's an inexpensive way to heat a bathroom, workshop or other small space—without sacrificing floor space. The Heatwave electric heater is a lightweight, wall-mounted unit that circulates up to 5120 BTUs of heat per hour with a superquiet axial fan. It can also be used as a fan only to keep a room cool. The 5 1/2 x 8-in.-wide x 8 1/2-in.-high heater costs \$33. Intermatic, Intermatic Plaza, Spring Grove, IL 60081.

Press-In-Place Caulk



Here's a quick, easy way to apply caulk—without a caulking gun. Manco's new Tape Caulk is a high-density butyl rubber caulk that provides a long-lasting, waterproof seal. To apply, press the caulk in place and peel off the paper backing. The 3/8-in.-thick x 1/2-in.-wide caulk comes in a 17-ft.-long roll for \$5. Manco, 2040 W. 110 St., Cleveland, OH 44102. **PM**

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This ad will explain every detail of an exciting new business that has never been advertised or attempted before—what's more, you can enter with absolutely no money.

Life was not always rosy for me. I got involved in a bad business investment a few years ago and lost about \$11,000. Everything I owned was taken away from me. I needed money desperately to feed my family, so I was forced to toil as a waiter at the Sheraton Harbor Island Hotel in San Diego by night, and I was a filing clerk during the day. It was so exhausting, that as soon as I got home, I would sleep for just a few hours, wake up in a stupor, drink four cups of coffee, and then scramble to my next job. I had no choice. It was the only thing I could do to stop disappointing my loved ones. I remember coming home on Mother's Day really eager to call my mother, only to find that my phone had been disconnected. I went through the mail praying for some good news, only to find an envelope with no return address—it contained an eviction notice. At this point I thought we would have to live in our beat-up Fiat. We were fortunate to have relatives that were kind enough to let us stay with them. I never knew life could be so miserable. I sat down on the sidewalk just realizing how much being in debt could hurt. With tears in my eyes, I prayed for a way out.

My friend Gary, who was in the same financial boat as I was, told me a story that changed my life forever. He told me very excitedly, "I received a funny-looking letter. When I first saw it, I thought it was another creditor making a claim on me. The letter told me about money that was rightfully mine—it said that if I signed the enclosed form, I would receive \$2,592.59. Things were so bad that I had nothing to lose, so I signed the form neatly and returned it to the company."

"Ten days later I received a check for \$2,592.59 with an explanation. A distant aunt had died and left \$4,320.98 in her savings account. The company that found me collected \$1,728.39. The firm had no trouble finding out that I was related to her. Just for matching up people with the same last names, that agency was making millions every year."

It was just then that an amazing idea popped into my mind. I was overcome with excitement; this revolutionary system was so simple, yet I knew it would take me out of my rut. I was compelled to find out more about it. I had lost everything I owned; what else could I lose? I found out everything I could and began to work on a plan. I put it into affect. My prayers were heard. To my relief I started to make more money than I have ever seen in my life for doing practically nothing. In fact, my income for just last month was \$50,076.78.

I had a C-minus average in high school—one year, I received an F in English. By no means was I ever considered to have the smarts. But I did it. All you have to do to make large amounts of money is thumb through

phone books and make a few phone calls.

Last summer we moved into a gorgeous home. My wife told me it was her life long dream to own a brand new car. You should have seen her tears of joy when I surprised her with her own new \$20,000 car. Later I bought a 1986 Mercedes 560SL that cost me \$56,000.

The amount of money I was making was incredible. Just as a hedge against taxes, I bought two three bedroom houses valued at \$200,000. I asked everyone in my family what they wanted the most and they said they wanted to see all of us traveling together. In the past month we have visited three countries. In fact, we take a vacation every month. It's great seeing the joy in everyone's eyes as I spend more time with them.

Twenty-five billion is just sitting there waiting for someone to recover it. One out of ten Americans have forgotten or lost money in bank accounts, stocks, insurance premiums, etc. This is money worth as much as the amount of \$10 bills you could lay end-to-end around the world; \$25 billion. I will disclose a plan to you that will show you how to get your hands on this money.

Only 10 percent of the rightful owners claim their share of the \$25 billion. The states make no strong effort to contact the rightful owners. Why should they, when unclaimed property is their biggest source of revenue, second only to taxes? The states are required by law to make a list of unclaimed owners. These lists are hard to find but I will show you how to get every one that the states publish. And in some cases, they're free.

Let me give you a random sample list from the state of Wisconsin. (Addresses are included in lists.)

Owner's Name	Property Amount
Drinka, Teresa	Savings \$10,891.47
Lavelle, Samuel	Stock Proceeds \$21,529.61
McDonnell, Martha	Savings \$2,843.78
Meyer, Thuseinda	Savings \$8,489.18
Patterson, Authur	Savings \$4,629.24
Stein, George	Savings \$57,525.83

This listing is only a minor portion of the \$25 billion in unclaimed property that is waiting for you.

California still hasn't found the owner of one account worth \$186,000. Someone in Massachusetts left behind \$400,000. North Carolina owes one person \$500,000.

**Found
\$20,197,323.97**

I have been able to locate and notify 421 claimants (worth \$20,197,323.97 in claims). I have made over \$300,000 since I last wrote you Dave.

Herb H., TX

**Found Over
\$500,000**

As a result of buying and using your course I have contracted for over \$500,000 of other peoples money in the last 100 days. It really makes me feel good to help people while making money. Often I get invitations to dinner and thank yous from people I have helped.



Nathaniel H., TX

**\$4,374 For
Two Hours**

I saw the ad for your book, sent off for it, then studied its methods.

It took a couple of hours to make the first week's \$4,374, and so far I have earned \$36,846 as a direct result of your course. At 17, I had no background at this kind of work. My friends thought I didn't have a job, yet I was making more money than they have ever made. With the money I made I bought a brand new car and the rest I am saving for college. Thanks Dave.



Vic H., MI

**Secured
\$299,700**

I have spent a lot of money on the many

other "ideas", but this one has very definite potential. I have located over one hundred (100) people that are owed a combined total of over \$299,700. By applying your techniques about four hours a day I have been able to find people.



Irvin J., VA

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Send for my complete guide to recovering unclaimed money. Read the simple formula that has been tailored for each individual state. Sit down and make the required few phone calls and directory searches. After following the simple formula, you must be able to recover \$10,000 in one day or your complete payment will be returned to you.

This opportunity can give you a new home, car and all of the luxuries money has to offer. Think of what \$10,000 today could do for you. Could you use this kind of money? There is a definite flaw in our revenue system, and you can profit from it.

David Bendah (619) 265-8777
6602 El Cajon Blvd., Suite B
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Dear Dave:
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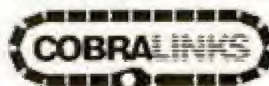
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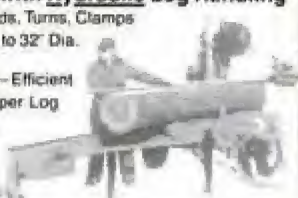
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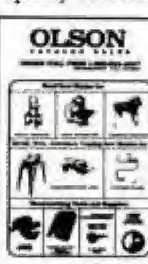
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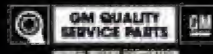
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